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Heidelberg 21. Mai '97

Hochgeachteter Herr Professor!

Für die freundliche Erwiderung, die
 mich hoch erfreut hat, Ihnen viel
 Dank zu sagen, möchte ich mir
 nicht länger erlauben. Ich hätte
 es am liebsten persönlich getan,
 da mir aber bisher die Gelegenheit
 dazu fehlte, tue ich es nun schriftlich.
 Ich freue mich ganz außerordentlich,
 wenn Sie sich in einem, wie ich
 persönlich mit Ihnen fand, zu begreifen,
 dass Sie mir persönlich gesondert
 sind. Geführt hat Sie ich.

1

2

Entweder hätte ich mich persönlich
 einem neuen Abdruck eines Vortrags
 auf der Frankfurter Versammlung
 zu senden - zugleich in Erwägung
 der dankbaren Abdrücke. Ich darf
 wohl noch besonders bemerken,
 dass der Gegenstand der Vorträge
 als nichts weiter wie eine bloße
 Hypothese auch von mir aufge-
 fasst ist. Die Hypothese durch
 neue Thatfachen zu stützen habe ich
 mir weiter viele Mühe gegeben,
 bisher ohne noch Erfolg gehabt
 zu haben. Meine Arbeiten sind
 in den letzten Jahren sehr oft in
 den Zeitschriften erschienen. Für
 einige Zeit habe ich meine frische
 Vermuthung mit den Kathodenstrahlen
 in der feinen Luft wiederholt, um zu
 sehen, ob ich in ihnen

3

ähnliche andere Kationen
 und es hätte mir das sehr
 gelassen, aber ich habe
 unheimlich an die Röntgenstrahlen,
 welche solche Ladungen
 können, ich habe an Röntgen
 Polemik auch mit in meinem
 beigewirkt. Dass die ganze
 Entdeckung so rasch so schnell
 samkeit der Welt, dass sie
 auf meine besonderen Arbeiten
 gestellt hat, was ich besonders
 glücklich für mich und die
 Welt, wenn man sich
 Gedanken über die Natur
 darüber freuen. Hoffentlich
 wird das für mich

suchen, dass Sie durch die Vorlesung
 diesem der von Ihnen mitgetheilten
 Strahlenart gelehrt werden war,
 dass Sie die in meiner Hypothese
 ganz gefunden, dass Sie nicht
 so viel war, dass also das von
 den Kathodenstrahlen erzeugten
 Eigenschaften, alle wirklich
 stark abweichenden Strahlen
 zu kommen. Trübsinn ist es
 bald möglich, Ihnen gemacht
 werden in diesem

Mit wiederholtem Dank
 und in größter Hochachtung
 verbleibe ich

Hr.

Prof. Röntgen

P. Röntgen

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FIG. 4. Lenard's letter to Röntgen (with translation).

Heidelberg, 21 May '97

HIGHLY ESTEEMED PROFESSOR:

For your kind letter that I was happy to receive, I thank you many times. I had preferred to have done it personally but as I had no opportunity so far I'm writing to you. I was particularly happy to know for sure, what I had never any reason to doubt, that you are friendly toward me. I was often afraid it could have been otherwise and I would have been sorry for that. However, I am completely innocent of any remarks which could have caused this to be. I never took part in any of the slightest Polemics. Because your great discovery caused such swift attention in the farthest circles my modest work also came into the limelight, which was of particular luck for me, and I am doubly glad to have had your friendly participation. Again many thanks that you wrote to me. Enclosed permit me to send you a copy of a lecture to the Frankfurt Congress (in English since

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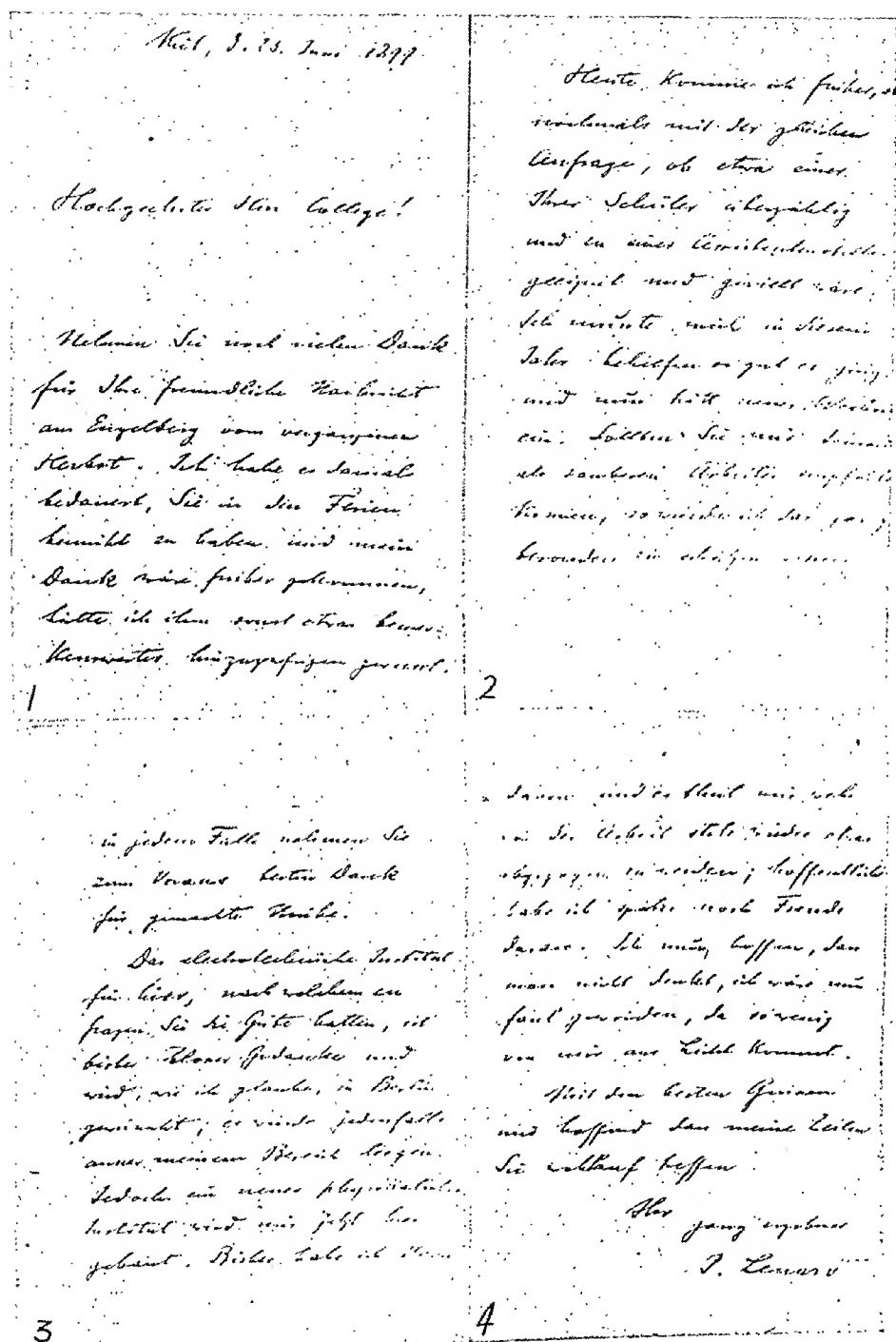


FIG. 5. Letter from Lenard to Röntgen, Kiel, June 23, 1899 (with translation)

KIEL, the 23 June 1899

HIGHLY ESTEEMED COLLEAGUE:

Accept again my best thanks for your kindly notification from Engelberg last fall. I was sorry then to have troubled you on your vacation and my thanks would have come earlier had I been able to add something better.

Today I come earlier but again with the same request, whether one of your students would be available and able and willing to accept a position as assistant. I had to help myself this year as well as I could and now

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severe injury of the limbs, with or without fracture, commonest in the upper limbs. Most of the patients are children and it is particularly frequent in patients with supracondylar fracture. The exact cause of the condition is not known but it is certain that circulatory disturbances and irritative lesions of the periarterial sympathetic nervous system are factors in its causation. Sometimes it is brought about by injuries of the nerves during operation and sometimes by improperly adjusted plaster casts.

Treatment may be surgical, orthopedic and physiotherapeutic. Early operation in the beginning of the condition may prevent the development of the later more serious stages. Operations that may be performed at this time are aponeurotomy, periarterial sympathectomy and arteriectomy. Delayed operations some weeks after the beginning of the disease may improve the condition; these operations are sympathectomy, arteriectomy and treatment of the nerve lesions. Late operations can only partially correct the sequels of the disease; these are operations on the bones, muscles and tendons. Orthopedic treatment must be well chosen and prolonged.

Plaster casts should always be adjusted carefully and the patient watched so that if the slightest sign of contracture develops the cast may be removed and correction made. As the condition is sometimes caused by manipulations in reducing fractures these should always be carried out as gently and carefully as possible.—*Audrey G. Morgan.*

GARBER, ROBERT L. Rhabdomyosarcoma of the extremities. *Radiology*, June, 1944, 42, 595-596.

Rhabdomyoma occurs chiefly in the genitourinary tract, though some cases have been described in the extremities, chiefly the lower.

The only effective treatment is surgical removal and then they show a tendency to local recurrence. Leucutia reports a series of 3 cases of rhabdomyosarcoma, in a total of 3,000 cases of malignant tumor of all types, none of which was influenced by irradiation.

The author describes a case in a man of sixty-eight who for about six months had had pain in the left shoulder. When he came for examination there was a large firm mass at the upper end of the humerus, definite limitation of movement and constant pain. Roentgen examination showed a large, irregular area of

destruction at the upper end of the humerus with bony spicules extending into the soft tissue mass. The appearance suggested primary osteogenic sarcoma. There was no evidence of metastasis. Roentgen treatment had no effect and the tumor was removed surgically. It was a large hemorrhagic tumor the size of a grape fruit involving the upper third of the humerus. A photomicrograph of a section is given. It shows cellular pleomorphism and many giant multinucleated cells. There were areas of degeneration, necrosis and hemorrhage. It apparently originated in skeletal muscle, making it a rhabdomyosarcoma.

The wound healed promptly; six months later the patient was in good general condition but movement of the arm was limited.—*Audrey G. Morgan.*

BLOOD AND LYMPH SYSTEM

SMITH, BEVERLY C., and QUIMBY, EDITH H. The use of radioactive sodium in studies of circulation in patients with peripheral vascular disease; preliminary report. *Surg., Gynec. & Obst.*, Aug., 1944, 79, 142-147.

The viability of an extremity is dependent upon the arterial blood which reaches it through its main arteries or through their branches which constitute the collateral circulation. Prognosis and results of therapy in peripheral vascular disease could be more accurately judged if a simple objective method were available for measuring the arterial flow through these two circulations. Most of the available physiological tests are clinically impracticable. In searching for a practical procedure, it was decided that if radioactive sodium were injected intravenously at the antecubital fossa, its arrival in other parts of the body could be recorded by a Geiger-Müller counter and thus circulation time from arm to any desired region obtained. Since there is constant interchange of sodium between blood plasma and extravascular fluid, the amount of radioactive isotope will increase in any particular region until equilibrium is attained. This can be followed by the rate of response of the counter. The manner in which this equilibrium is built up may be related to the degree of pathological change in the vessels of the extremity.

In addition to normals, the following types of case have been studied: arteriosclerosis, with and without diabetes, peripheral thrombosis and embolus, thromboangiitis obliterans, sclero-

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No. 1

THE ROENTGEN DIAGNOSIS OF DOUBLE AORTIC ARCH AND OTHER ANOMALIES OF THE GREAT VESSELS*

By EDWARD B. D. NEUHAUSER, M.D.
BOSTON, MASSACHUSETTS

THE MAJOR anomalies of the aortic arch and great vessels at the base of the heart have been well known to anatomists and pathologists for many years, but until the present time many of these anomalies have been considered of academic interest only. However, with perfection of surgical technique and mastery of the problems of preoperative and postoperative care, most of those anomalies that are disabling or fatal in their effects are now amenable to surgical cure or improvement.

The following classification has been adopted for the purposes of this discussion:

I. *Right Aortic Arch*

A. *Situs inversus viscerum*

B. *Right aortic arch without inversion*

1. *Anterior type*—The aortic arch is anterior to the trachea, and the descending aorta is on the right side.
2. *Posterior type*—The aorta passes to the left behind the esophagus, and the descending aorta courses to the right of the normal left-sided position.

- a. *Right aortic arch in which the left subclavian artery arises last from the arch and crosses behind the esophagus to its distribution.*
- b. *Right aortic arch in which no vessel arising from the arch crosses the midline posterior to esophagus.*
- c. *Right aortic arch with a persistent left aortic diverticulum giving origin to the left subclavian artery. No vessel from the arch crosses the midline posteriorly.*

II. *Double Aortic Arch*

A. *Both aortic limbs patent*

B. *One aortic limb obliterated*

III. *Anomalous Right Subclavian Artery.* The artery arises last from a normal aortic arch and crosses the midline to its distribution on the right side.

IV. *Patent Ductus Arteriosus*

V. *Coarctation of the Aorta*

Although knowledge of the development of the six-paired aortic arches that develop during embryonic life is essential for a

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FIG. 1. M.O'D., infant female. Persistent posterior right aortic arch with vascular ring formed by the pulmonary artery and the patent ductus arteriosus. There is a large rounded pressure defect on the posterior aspect of the esophagus at the level of the aortic arch. The trachea is narrowed and is displaced forward. Pressure from the common carotid evidently produced the narrowing of the trachea just above the level of the aortic arch, and pressure from the pulmonary artery produced pressure changes just below the level of the arch.

complete understanding of the pathogenesis of these anomalies, only a minimum will be presented in this paper as the subject has been discussed in many papers and texts of embryology,^{3,7,11} and will be completely covered in a paper to be published by Owyang and Farber.

There are six pairs of aortic arches that develop at various times in the embryo. The cephalad arches develop first only to disappear as the more distal develop. The final normal pattern of development is thought to be as follows: the proximal part of the third arch becomes the common

carotid. The left fourth becomes the aorta, while the proximal part of the right fourth arch becomes incorporated in the right subclavian. The proximal parts of the sixth become the pulmonary arteries, and the distal part of the left sixth becomes the ductus arteriosus. Normally, the other portions of the arches disappear. Anomalies of the great vessels result from persistence of normally obliterated arches or segments, with disappearance of portions that should normally be present.

The clinical significance of these anomalies and methods of cure by surgical means will be discussed in a companion paper from the Children's Hospital by Gross and Ware.¹⁹ In my paper the discussion will be



FIG. 2. R.K., infant male. Vascular ring, probably a double aortic arch. Patient has stridor and occasional attacks of bronchitis. The symptoms have not been sufficiently severe to warrant operation. Lateral roentgenogram of the chest shows slight anterior displacement of the trachea with considerable narrowing at the level of the aortic arch.



FIG. 3. R.K., infant male, same case as Figure 2. Anteroposterior and lateral roentgenograms of the chest with barium in the esophagus. There is no lateral shift of the esophagus but there is marked narrowing of the esophagus from both the right and the left sides. In the lateral projection the large rounded posterior defect produced by the right aortic arch is clearly seen, and there is less well defined pressure on the anterior aspect.

limited to the roentgen diagnosis and it is to be emphasized that in many of these conditions the diagnosis can be made only by means of an adequate roentgenologic examination. The criteria for roentgen diagnosis is understood in many of these anomalies and in such cases a brief résumé of the salient features and appropriate references will be given.

Right Aortic Arch. There have been many excellent papers^{5,6,9} devoted to the roentgen diagnosis of right aortic arch, and repeated reference must be made to the excellent and thorough study by Fray.⁷ The diagnosis of right aortic arch can be made only by roentgenologic examination. The diagnosis can be frequently suspected from the posteroanterior roentgenogram alone as the aortic arch may be observed to be the right of the midline with absence of the aortic "knob" from its usual position. The main portion of the shadow of the "knob" is cast by the descending limb of the aortic arch and, as this limb lies either in the midline or

to the right of the midline in most cases, the "knob" is not seen in its usual position. In addition, there may be very slight deviation of the trachea to the left. The determination of the exact type of right aortic arch must be made by observing the deflections and defects in the barium-filled esophagus.

The right aortic arch associated with situs inversus viscerum is of course part of transposition of all of the viscera or of dextrocardia alone and need not be considered here. The anterior right arch without inversion will produce a defect on the right side of the esophagus and possibly produce a slight displacement of the trachea and esophagus to the left. There should be no defect on the posterior aspect of the esophagus. These two anomalies are of little importance as symptoms from the arch deformity alone are not to be expected. There is no embryological relationship of this anomaly to the other deformities considered in this paper.

The recognition of the posterior right aortic arch and its clear differentiation from double aortic arch and an anomalous right subclavian artery is of considerable importance as it is these malformations which may lead to severe and disabling symptoms. A posterior right aortic arch passing behind the esophagus with the descending limb passing to the right of the normal left-sided position may be of three types. In each the basic deformity of deviation of the esophagus to the left with a rounded defect on the right lateral aspect and on the posterior aspect of the esophagus will be evident. In type 2a, where in association with the posterior right aortic arch, the left subclavian arises as the last vessel from the arch the basic deformity will be modified as Renander¹⁶ has shown. The left subclavian as it passes to the left side behind the esophagus to its distribution creates on the posterior aspect of the esophagus an oblique defect running up-

ward from right to left just above the defect produced by the right arch itself. This deformity is illustrated in the paper by Gross and Ware.¹⁹

The posterior right aortic arch type 2b appears to be the one most commonly recognized roentgenologically, and in nearly all cases the basic deformation of the barium-filled esophagus is all that is seen, as no vessel arising from the arch crosses the midline so as to produce a pressure defect on the esophagus. However, in the rare instance when symptoms are produced, as shown in Figure 1 a vascular ring is formed by the pulmonary artery and the ductus arteriosus or ligamentum arteriosum. The pulmonary artery is pulled back against the anterior aspect of the trachea by the ductus and will produce compression of the trachea as seen in the lateral view and probably a pressure defect on the left side of the esophagus at the level of the ductus as seen in the anteroposterior pro-



FIG. 4. F.R., infant. Double aortic arch proved at operation, and fully reported by Gross.¹⁰ Anteroposterior and lateral roentgenograms of the chest with barium in the esophagus. The appearance is essentially similar to that shown in Figure 3. The defect produced by the persistent posterior right aortic arch showed visible pulsation during roentgenoscopic examination, and there is erosion of the anterior aspect of several vertebral bodies at the level of the right arch. There is lipiodol in the partially atelectatic right middle lobe.

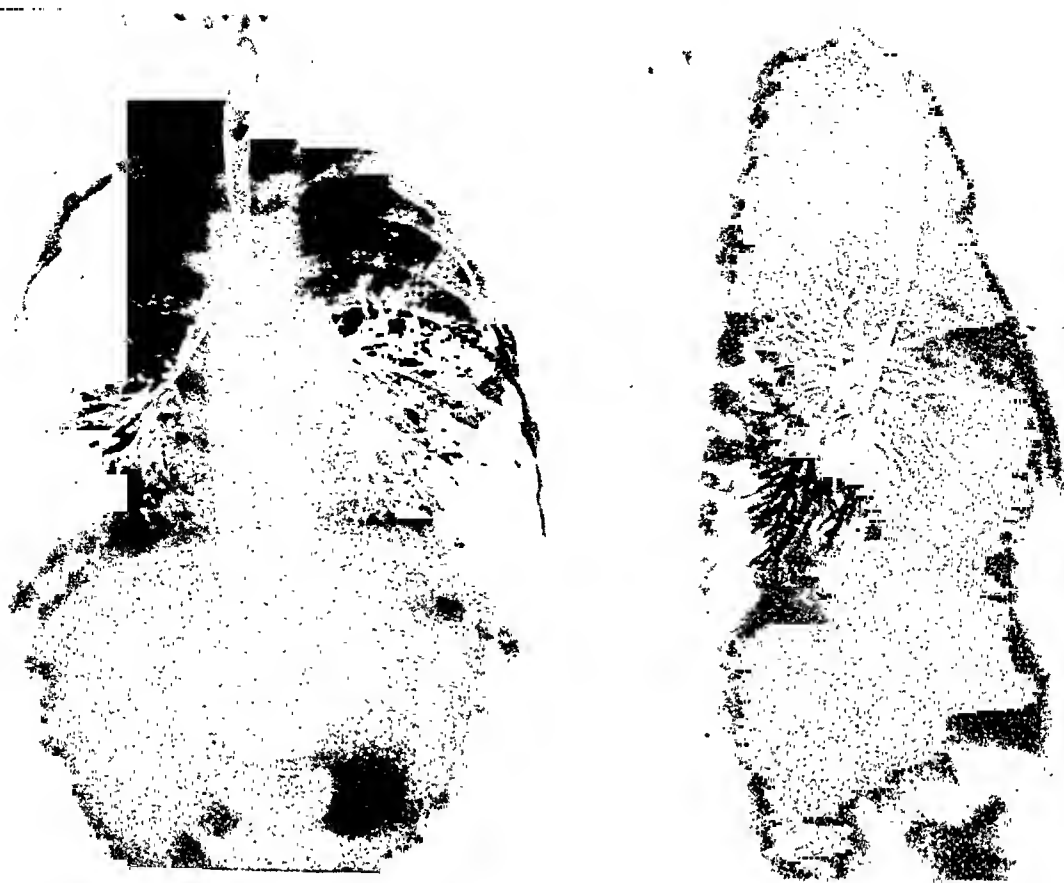


FIG. 5. F.R. Anteroposterior and lateral roentgenograms of the chest following instillation of lipiodol. There is marked narrowing of the trachea in all diameters just above the bifurcation at the level of the aortic arches.

jection. The common carotid also passes in front of the trachea from right to left and may contribute to the tracheal compression. The deformity produced by this type of constricting ring can be distinguished only with difficulty from that produced by a double aortic arch, particularly if the anterior limb of the double aortic arch is obliterated as occasionally occurs. The posterior defect in the barium-filled esophagus produced by the posterior right arch alone is of a size that would be associated with an aorta of the usual diameter, while in the double aortic arch the posterior defect is rarely more than half the expected size if both arches are patent. In the patient with evidence of tracheal and esophageal compression operative intervention to relieve the constriction is imperative. Undoubtedly in most patients the vascular ring is sufficiently loose so that no compression can be recognized.

The third form of posterior right aortic arch, class 2c, where there is persistence of

a left aortic diverticulum giving origin to the left subclavian artery roentgenologically can be distinguished only with difficulty from the previous type as no vessel crosses the midline behind the esophagus. Fray⁷ states that the defect on the posterior aspect of the esophagus in this type is due to the aortic diverticulum. Arkin² was able to visualize the diverticulum as it produced in his cases a shadow of increased density in the region of the posterior arch of the aorta behind the esophagus, that could be distinguished from the shadow of the arch itself. Tracheal compression from the pulmonary artery and ductus arteriosus may occur in association with this type of anomalous arch in a manner similar to that described for the second type.

Double Aortic Arch. The roentgen diagnosis of double aortic arch producing constriction of both the trachea and esophagus has been made four times at the Children's Hospital. Two of these patients have been



FIG. 6. C.G., infant female. Double aortic arch proved at operation. Anteroposterior roentgenogram of the chest with barium in the esophagus. There is rather marked encroachment on the esophagus from both the right and left sides without deviation of the esophagus.

operated upon by Dr. Robert E. Gross, and one case has been presented at considerable length.¹⁰ It is well known that occasionally a double aortic arch is found at autopsy or at the time of an anatomical dissection where it has been evident that no severe symptoms were produced. In this paper we are primarily interested in the constricting double arch that produces, as Wolman¹⁸ has described, a rather characteristic clinical picture in infants, although the diagnosis rests solely on roentgenographic examination. The onset of symptoms is usually in infancy and the patients with this syndrome usually present stridorous breathing, mild dysphagia, head retraction, chronic cough, and frequent attacks of pulmonary infection. The stridor is usually made worse by feeding.

In our 4 patients (Fig. 2 to 10) the roentgen changes appeared to be unmistakable and characteristic. In the pos-

teroanterior projection we have not been able to detect any abnormality of the heart or great vessels when no contrast substance was used as it is extraordinarily difficult to detect the position of the aortic arch in the young infant; but in the lateral projection it is possible to see narrowing and anterior displacement of the trachea at the level of the aortic arch. When the esophagus is filled with barium there appears a rounded pulsating mass posterior to the esophagus and this mass, the posterior right aortic arch, displaces the esophagus forward. In one of our patients there was apparent erosion of the anterior aspect of several of the vertebral bodies at the level of the aortic arch. This erosion was evidently due to the pulsation of the posterior arch in contact with the prevertebral soft tissues. In the anteroposterior projection there is no deviation of the barium-filled esophagus to



FIG. 7. C. G. Proved double aortic arch. Lateral roentgenogram of the chest with barium in the esophagus shows the characteristic posterior defect of the posterior right aortic arch but this is associated with pressure defect on the anterior aspect. This patient had severe symptoms of stridor, dysphagia and recurrent pulmonary infection.

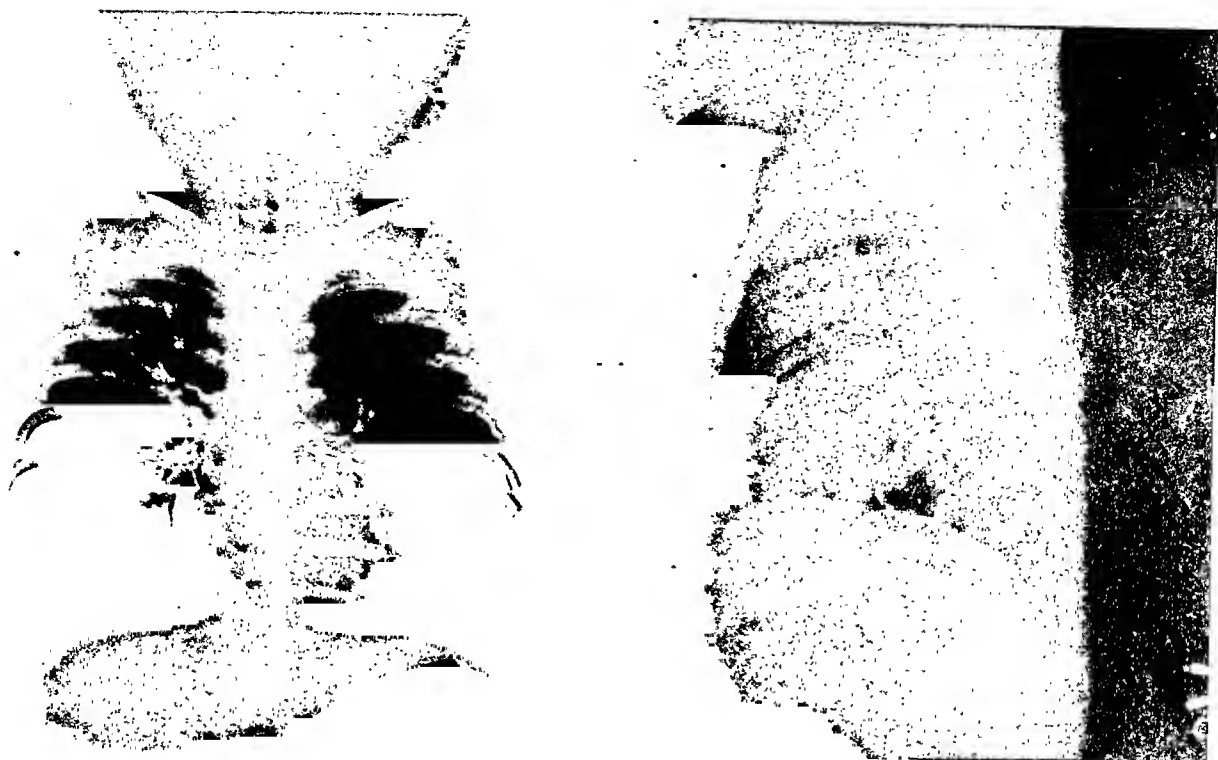


FIG. 8. C.G. Roentgenograms of the chest following instillation of lipiodol into the tracheobronchial tree. The appearance is apparently identical to that illustrated in Figure 5. There is slight anterior displacement of the trachea with narrowing in all diameters at the same level as the defects in the esophagus.



FIG. 9. S.L., infant female. Vascular ring, probably a double aortic arch. The patient has mild dysphagia and moderate stridor. The vascular ring evidently produces only moderate constriction. Anteroposterior and lateral roentgenograms of the chest with barium in the esophagus show at the level of the aortic arch a defect on the right and on the left sides, and a large defect posteriorly with moderate forward displacement. There seems to be very little pressure on the anterior aspect of the esophagus.



FIG. 10. S.L. Lipiodol roentgenograms show the deformity of the trachea characteristic of a vascular ring. The ring is probably quite loose as there is little evidence of pressure on the anterior aspect of the trachea. Some of the lipiodol has been swallowed and the deformity of the esophagus can be seen in relation to that of the trachea.

the left as is seen with the right aortic arch alone, but rather there is narrowing of the esophagus from both the right and the left sides due to the pressure of the vascular ring. Although these findings would appear to be diagnostic it seems wise to obtain satisfactory roentgenograms of the trachea after the instillation of a suitable opaque oil. When this is done a deformity of the trachea is seen similar to that visualized in the esophagus. The trachea is displaced forward at the level of the right aortic arch and it is narrowed from both the right and left sides by the pressure of the vascular ring and pressed upon by the left aortic arch anteriorly.

In each of the 2 patients operated upon there was an apparently identical anatomical variant which is described at greater length by Gross and Ware. The aorta arose normally from the left ventricle, but at the level of the arch divided into a posterior right aortic arch which passed behind the esophagus and into a left aortic arch which passed anterior to the trachea. The two

vessels then united to form a single trunk which passed downward in a relatively normal fashion. The anterior left arch was smaller than the posterior right, and as this is usual one may expect that the defect produced on the posterior aspect of the esophagus will be somewhat smaller than that to be expected from an aorta of normal size. Occasionally, the anterior or left aortic limb is obliterated, and although constriction is likely the posterior aortic arch would be of a size similar to the normal aorta. We have not attempted angiocardiology in any of our patients but excellent visualization should be obtainable, and this method is available if the diagnosis is in doubt.

Anomalous Right Subclavian Artery. This is perhaps the most common of all of the anomalies of the great vessels at the base of the heart, but the roentgen diagnosis appears to have been reported infrequently as Copleman,³ describing 1 case of his own, could find only 4 other cases diagnosed during life. We have made the

roentgen diagnosis in 10 cases, and 1 of these patients has been operated upon by Gross with confirmation of the preoperative diagnosis. As a rule, the anomaly produces no symptoms but occasionally severe dysphagia is produced by the pressure of the vessel on the esophagus. Dysphagia lusoria correctly refers to the difficulty produced by this anomaly and not to that produced by a right aortic arch.

When the right subclavian artery arises as the last vessel from the normal left aortic arch, it must cross the midline to its distribution on the right side. In the anatomical specimens collected by Holzapfel¹³ the artery passed to the right behind the esophagus in 107 cases, between the esophagus and trachea in 20, and in front of the trachea in 6 cases. In all of our patients,

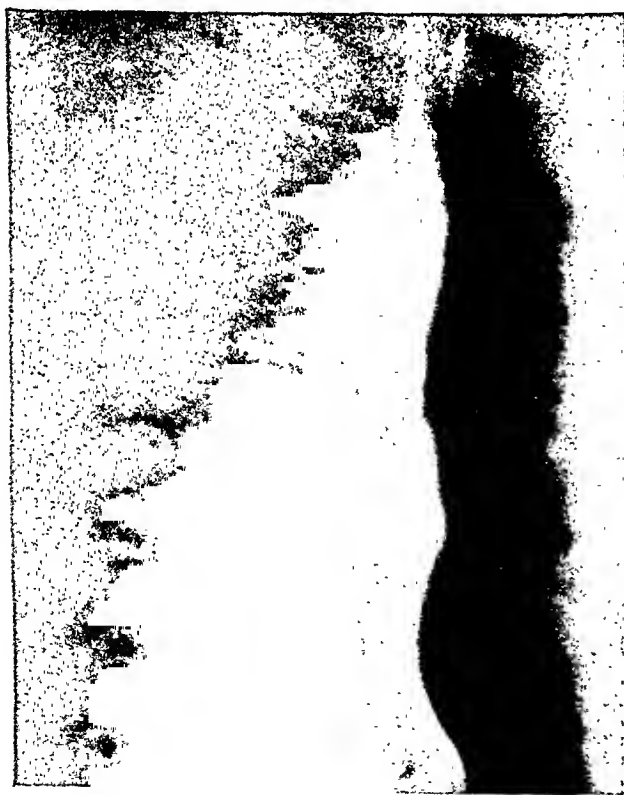


FIG. 11. J.R., infant male. Anomalous right subclavian artery arising as the last vessel from a normal aortic arch, and passing behind the esophagus to its distribution. The roentgen diagnosis was confirmed by Dr. Robert E. Gross at operation. Lateral view with barium in the esophagus shows a rounded filling defect on the posterior aspect of the esophagus. It is slightly above the level of the aortic arch and is smaller than a posterior defect produced by a posterior right aortic arch.



FIG. 12. J.R. The anomalous right subclavian as seen in the left anterior oblique projection a small oblique filling defect on the posterior aspect and the left lateral aspect of the barium-filled esophagus. The defect runs upward from left to right. Pulsations were evident, and at roentgenoscopy the normal aortic arch could be visualized.

and in those referred to by Copleman, the anomalous vessel has apparently been behind the esophagus. The roentgen picture is rather characteristic but it should not be confused with the deformity of the esophagus produced by a posterior right aortic arch. When the vessel passes from left to right behind the esophagus (Fig. 11 to 13), it produces an oblique defect that appears to be about 0.5 cm. in width. This defect passes upward from left to right on the posterior aspect of the esophagus just above the level of the aortic arch. The aortic arch can normally be seen in its usual position. On the left posterolateral aspect of the esophagus a notched defect is visible as shown in the accompanying illustrations. This defect is visualized on the right posterolateral aspect but is less prominent than on the left. The oblique defect can be readily detected in the anteroposterior



FIG. 13. D.McG., infant female. Anomalous right subclavian artery passing behind the esophagus. Not proved as the mild dysphagia did not warrant operation. Anteroposterior and lateral views of the chest with barium in the esophagus shows the typical oblique filling defect running upward from left to right behind the esophagus. In the anteroposterior projection the barium column shows diminution in depth as it passes over the anomalous artery.

projection if the barium swallowed is not too dense or too great in amount. When the vessel passes in front of the esophagus but behind the trachea a similar defect is produced (Fig. 14 and 15), but it is on the anterior rather than on the posterior aspect of the esophagus. The occasional vessel that passes in front of the trachea would probably produce no demonstrable defect or constriction of the trachea.

Patent Ductus Arteriosus. Careful roentgenoscopic examination will frequently lead to the correct diagnosis of patency of the ductus arteriosus, but in many instances positive findings are minimal or absent if the ductus is of small caliber.⁴ If variations from the normal appearance of the heart are noted the following changes will be observed in order of frequency: (1) dilatation of the pulmonary artery; (2) cardiac enlargement; (3) enlargement of the left auricle; (4) engorgement of the intra-

pulmonary vessels; (5) exaggerated pulsation of the ascending aorta, pulmonary artery, and the left ventricle; (6) unusually prominent pulsation of the vessels at the hila. Steinberg, Grishman and Sussman¹⁷ have shown that by angiocardiology it is frequently possible to demonstrate a small sacculum or "out-pouching" of the aorta at the level of the ductus. The ductus itself cannot be visualized.

Coarctation of the Aorta. The roentgenologic examination is often not diagnostic but invariably yields useful information.⁷ Moderate cardiac enlargement is to be expected. The enlargement and altered contour of the heart is due to hypertrophy of the left ventricle as can be demonstrated in the right anterior oblique and postero-anterior projections. However, Perlman,¹⁶ in reviewing 13 cases, found no evidence of enlargement of the left ventricle in 4 of his patients, and he felt that there was no

correlation between the size of the left ventricle and the degree of elevation of the blood pressure. The ascending aorta will frequently appear to be slightly dilated but the aortic "knob" is always smaller than normal and may be quite invisible. The descending limb of the aorta is usually not visualized. Accurate delineation of the constricted portion of the aorta may be obtained by angiocardiology. Notching of the inferior margin of the ribs in the posterior third is perhaps the most valuable sign but is not reliable in the early age group. We have observed definite notching at the age of eight years, and in 1 patient at nineteen months of age. Notching of the first three ribs should not be expected. The correct diagnosis can occasionally be suspected by noting enlargement of the dental pulp cavity of the deciduous or permanent maxillary incisors.¹⁴

In conclusion, it must be emphasized that these anomalies can no longer be considered rare. Roentgenographic studies afford the only means by which a certain diagnosis can be established. Careful roentgenographic and roentgenoscopic examination should be carried out on every patient who exhibits



FIG. 15. Same case as Figure 14. Right anterior oblique view shows the anterolateral defect just above the arch of the aorta. The deformity is essentially similar to that produced by the subclavian passing posterior to the esophagus except for its anterior position.

dysphagia, wheezing, stridor, or recurrent attacks of tracheobronchitis and pneumonia. Prompt surgical treatment should yield satisfactory relief of the disabling symptoms produced by esophageal and tracheal compression.

SUMMARY

1. Anomalies of the aortic arch are common, many are clinically significant, roentgenologically demonstrable, and amenable to surgery.

2. The nature of many of these anomalies may be determined by characteristic combination of great vessel shadows, lateral deviations of the trachea and esophagus, rounded pressure defects in the contour of the trachea, and rounded or oblique defects in the contour of the esophagus.

3. Right-sided aortic arch may be detected in the posteroanterior roentgenogram by demonstration of a right-sided aortic "knob" with deviation of the trachea to the left.



FIG. 14. Adult male with symptoms of dysphagia. Anomalous right subclavian artery arising from the normal arch and passing to its distribution between the trachea and the esophagus. Anteroposterior and lateral spot roentgenograms of the barium-filled esophagus show a small rounded oblique defect on the left lateral and anterior aspect of the barium column.

I am indebted to Drs. Copleman and Robb for permission to use Fig. 14 and 15.

4. A right aortic arch passing posterior to the esophagus produces a rounded defect on the posterior aspect of the esophagus with deviation of the esophagus to the left. A combination of a posterior right aortic arch with a left subclavian passing from right to left behind the esophagus may produce in addition a smaller oblique defect in the posterior esophageal wall above the defect produced by the aorta. If a persistent left aortic diverticulum is present in combination with a posterior right aortic arch a double rounded defect may be observed on the posterior aspect of the esophagus.

5. A constrictive double aortic arch produces narrowing of the trachea and esophagus from both sides, anterior displacement of the trachea, and compression of the trachea as seen in the lateral projection. In both the constrictive and non-constrictive types of double aortic arch, a rounded defect in the contour of the esophagus is present posteriorly.

6. A right subclavian artery arising from the arch of the normal aorta as the last branch of the arch may pass to its distribution on the right side in front of the trachea but will in most instances pass behind the esophagus; a characteristic small, oblique filling defect is produced. In a small percentage of cases the anomalous artery passes between the esophagus and the trachea and in such cases the typical oblique defect will be on the anterior aspect of the esophagus.

7. A summary of the roentgen findings in patent ductus arteriosus and coarctation of the aorta is presented. Two additional patients with double aortic arch have been seen since this paper was submitted for publication.

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REFERENCES

1. ARANA, M. R., and AGUIRRE, R. S. Doble arco aórtico en un niño. *Arch. argent. de pediat.*, 1940, 11, 331-342.
2. ARKIN, A. Quoted by Sprague, H. B., Ernlund, C. H., and Albright, F. Clinical aspects of persistent right aortic root. *New England J. Med.*, 1933, 209, 679-686.
3. COPLEMAN, B. Anomalous right subclavian artery. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 54, 270-275.
4. DONOVAN, M. S., NEUHAUSER, E. B. D., and SOSMAN, M. C. Roentgen signs of patent ductus arteriosus. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 50, 293-305.
5. EISEN, D. Right aortic arch with report of eight cases. *Radiology*, 1944, 42, 570-578.
6. FABER, H. K., HOPE, J. W., and ROBINSON, F. L. Chronic stridor in early life due to persistent right aortic arch. *J. Pediat.*, 1945, 26, 128-137.
7. FRAY, W. W. Right aortic arch. *Radiology*, 1936, 26, 27-36.
8. FRAY, W. W. Roentgenologic diagnosis of coarctation of aorta (adult type). *AM. J. ROENTGENOL. & RAD. THERAPY*, 1930, 24, 349-362.
9. GARLAND, L. H. Persistent right-sided aortic arch. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1938, 39, 713-719.
10. GROSS, R. E. Surgical relief for tracheal obstruction from a vascular ring. *New England J. Med.*, 1945, 233, 586-590.
11. HERBUT, P. A. Anomalies of the aortic arch. *Arch. Path.*, 1943, 35, 717-729.
12. HERBUT, P. A., and SMITH, T. T. Constricting double aortic arch. *Arch. Otolaryng.*, 1943, 37, 558-562.
13. HOLZAPFEL, G. Quoted by Goldbloom, A. A. Anomalous right subclavian artery and its possible clinical significance. *Surg., Gynec. & Obst.*, 1922, 34, 378-384.
14. LOSCH, P. Personal communication.
15. PERLMAN, LAWRENCE. Coarctation of the aorta; clinical and roentgenologic analysis of 13 cases. *Am. Heart J.*, 1944, 28, 24-38.
16. RENANDER, A. Roentgen-diagnosed anomaly of oesophagus and arcus aortae. *Acta radiol.*, 1926, 7, 298-308.
17. STEINBERG, M. F., GRISHMAN, A., and SUSSMAN, M. L. Angiocardiography in congenital heart disease; patent ductus arteriosus. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 50, 306-315.
18. WOLMAN, I. J. Syndrome of constricting double aortic arch in infancy. *J. Pediat.*, 1939, 14, 527-533.
19. GROSS, R. E., and WARE, P. F. Surgical significance of aortic arch anomalies. *Surg., Gynec. & Obst.* To be published.

ANOMALOUS RIGHT SUBCLAVIAN ARTERY ORIGINATING ON THE LEFT AS THE LAST BRANCH OF THE AORTIC ARCH*

REPORT OF A PROBABLE CASE DIAGNOSED ROENTGENOLOGICALLY

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THE best known anomaly arising from variation in the developmental pattern of the aortic arch system is persistent right-sided aortic arch, a well recognized entity roentgenologically. On the other hand, origin of the right subclavian artery on the left as the last branch of the aortic arch, while not an infrequent anomaly, has been diagnosed in life by roentgenologic methods only in recent years. This small number of reported diagnoses of anomalous right subclavian artery in comparison with its relatively frequent occurrence anatomically has made it appear desirable to publish the findings in the following case, which differs in certain respects from those previously reported.

The earliest descriptions of this anomaly appeared in the first part of the eighteenth century, and by 1899 Holzapfel⁹ was able to collect 193 cases from the literature. The abnormality was found in 19 of 2,291 anatomical preparations reported by eight investigators.⁴ In a number of series the incidence reported has varied from 0.4 to 2.0 per cent.¹² In this connection it is interesting to note that Abbott¹ in her analysis of 1,000 cases of congenital cardiac lesions recorded only 7 examples of this condition. Kommerell¹⁰ was apparently the first to describe the characteristic roentgen findings. His report, appearing in 1936, was based on a single case. Four further cases^{6,7,12} have been reported subsequently in the European literature; 1 of these, that of Zdansky, was confirmed by postmortem study.

In the transformation of the embryonic aortic arch system toward the usual adult human pattern, the right dorsal aorta becomes interrupted caudad to the origin of

the primordial right subclavian artery.⁵ The subclavian artery thus takes its origin either separately as the first branch of the aortic arch or with the common carotid from the innominate (Fig. 1, *A*). The anomalous right subclavian results from interruption of the right aortic arch cephalad to the origin of the primordial right subclavian. The latter then arises from the

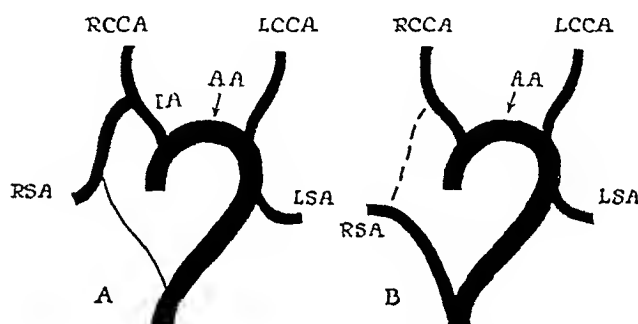


FIG. 1. *A*, diagram of usual aortic arch system in the 18 mm. human embryo (after Congdon). The right subclavian artery arises as a branch of the innominate, the caudal portion of the right dorsal aorta disappearing. *B*, development of anomalous right subclavian artery, the caudal portion of the right dorsal aorta persisting while the cephalic portion disappears (after Anson). (*AA*—aortic arch; *IA*—innominate artery; *RCCA*—right common carotid artery; *LCCA*—left common carotid artery; *RSA*—right subclavian artery; *LSA*—left subclavian artery.)

cephalic end of the unpaired dorsal aorta and passes cephalad and to the right usually dorsad to the esophagus (Fig. 1, *B*). The anomalous subclavian thus becomes the last branch of the aortic arch. A remnant of the right aortic arch occasionally persists as a diverticulum-like or aneurysmal outpouching at the origin of the subclavian artery from the distal portion of the aortic arch.

* The views expressed are those of the authors and do not necessarily reflect those of the Navy Department.

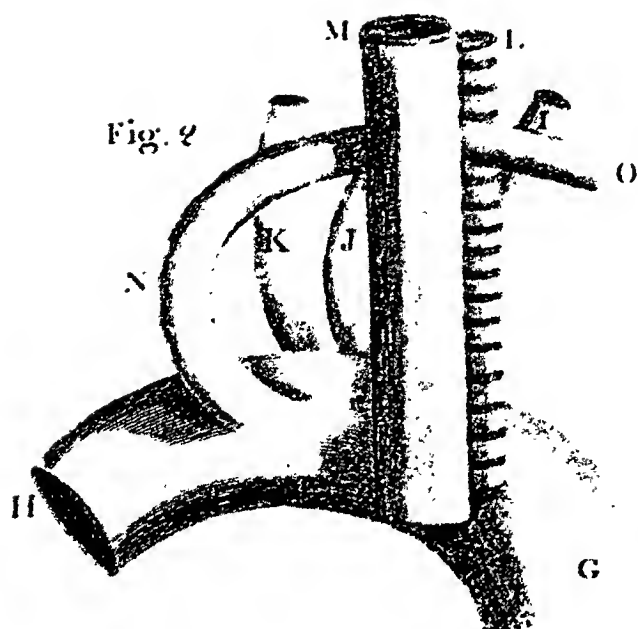


FIG. 2. Diagrammatic representation (dorsal view) of origin and course of anomalous subclavian artery in one of the earliest reported cases (photostatic reproduction of plate from Bayford's original paper). The vessel was stated to pass between trachea and esophagus; marked dysphagia was present ("dysphagia lusoria"). (G—ascending aorta; H—descending aorta; I—right common carotid artery; J—left common carotid artery; K—left subclavian artery; L—trachea; M—esophagus; N and O—anomalous right subclavian artery.)

The striking roentgenologic finding¹¹ is the presence of a small semicircular indentation (described as finger sized) in the dorsal aspect of the barium-filled esophagus at the level of the upper margin of the aortic arch. This impression is attributed to the aneurysmal origin of the anomalous subclavian artery. A soft tissue shadow representing the vessel may be identifiable and the presence of pulsations in the indentation aids in confirming the diagnosis. Kommerell states that the diagnosis can only be made roentgenologically when an aneurysmal origin of the vessel is present; this would explain the paucity of roentgenologic diagnoses of the condition recorded to date, since Holzapfel found such diverticula in only 33 of 51 cases. Dahm also and other writers are of the opinion that the possibility of demonstrating this anomaly does not exist if the subclavian in

the neighborhood of the esophagus is of normal caliber. This seems even more apparent when the many variations in origin and course of the anomalous artery are taken into account. The origin is usually from the posterior wall of the aortic arch where it approaches the vertebral column and more rarely from the upper wall. If the arch swings widely to the left the origin may be from the medial wall. The angle of origin can be sharp, right, or obtuse. As the origin is always deeper than the first rib, the vessel always courses upward and to the right. According to Holzapfel, the crossing over in the midline is from C₆ to D₄. The vessel occasionally passes in front of the esophagus, between it and the trachea, and still more rarely it passes in front of the trachea. It may be noted that the anatomical specimen from Zdansky's case, which showed a well marked esophageal indentation, did not show a significant dilatation of the right subclavian at its site of origin from the aortic arch, as far as can be determined from scrutiny of the published photograph.

Caudal to the abnormal indentation of the esophagus the aortic arch impression is apt to be poorly defined. The impression due to the subclavian artery in the cases reported has been more marked in the left than in the right anterior oblique views. This again has been attributed to the position of the diverticular origin on the aortic wall. In the right oblique position the shadow of the contrast material in the esophagus may be rendered less intense just above the level of the aortic arch due to the pressure from the left by the anomalous artery. Dahm indicates that anatomical preparations suggest that compression from the right is possible in some cases. No abnormality of the great vessel contours seen in the anterior view has thus far been recorded.

The history of this anomaly is intriguing. Its early recognition anatomically led to the concept, which apparently was widely held in the early nineteenth century, that it was a frequent cause of dysphagia. Bay-

ford,³ in an interesting paper entitled "An Account of a Singular Case of Obstructive Deglutition," published in the "Memoirs of the Medical Society of London" in 1789, presented in detail the clinical and postmortem findings. In this case dysphagia accompanied by a sense of suffocation was prominent from childhood, and the patient succumbed of inanition in her-sixty-first year. Autopsy showed the right subclavian artery arising on the left and crossing to the right between the esophagus and trachea. A photostatic copy of one of Bayford's original plates is reproduced herewith (Fig. 2). For the swallowing difficulty in this case Bayford coined the term "dysphagia lusoria," a minor anomaly being referred to in his time as a "lusus Naturae," i.e., a prank of nature. The popularity of this diagnosis waned with the coming of the era of anatomic pathology but the term has persisted in connection with discussions of persistent right-sided aortic arch as well as of left-sided origin of the right subclavian artery. Dysphagia is now thought to occur in the latter condition only when the origin of the abnormal vessel is aneurysmal.

It has been suggested^{2,8} that such changes as inequality of the radial pulses, enlargement of the thoracic duct, and symptoms like those in the scalenus anticus syndrome might be produced by the aberrant right subclavian artery.

Our observations relative to the great vessels were made incidentally in the course of the clinical study of a twenty-two year old male with a history of rheumatic heart disease. The patient was admitted to the hospital complaining of a pulling pain in the left side of the chest, radiating to the right shoulder, which had been present on effort since the age of fifteen years. The past history included episodes of epistaxis and wandering joint pains occurring after an attack of scarlet fever at the age of nine. From the ages of thirteen to sixteen years he had taken digitalis because of ankle edema. There had been no swallowing difficulty. Physical examination showed a robust young adult male. The blood pressure was 146 mm. Hg systolic/92 diastolic; the pulse, 92 per minute. Examination

of the heart revealed a mitral presystolic thrill and murmur followed by a systolic murmur; the last, transmitted toward the axilla. An aortic systolic murmur was transmitted into the neck. The electrocardiogram showed no unusual features, and laboratory studies were negative. The liver and spleen were not enlarged, and there was no palpable peripheral lymphadenopathy.

Roentgenoscopic examination and roentgenograms of the chest revealed no cardiac enlargement, the contour of the heart proper appearing normal. However, in the anterior view a small convex prominence was evident on the left just above the shadow of the aortic knob. The latter was identifiable by the level of the indentation in the esophagus due to the aortic arch (Fig. 3). The impression was gained roentgenoscopically that this accessory shadow exhibited intrinsic systolic pulsation. On contrast visualization of the esophagus in the lateral and right anterior oblique views, a small indentation of the dorsal wall of the esophagus was evident opposite the body of the fourth thoracic vertebra and immediately above the ventral impression due to the aortic arch (Fig. 4 and 5). The abnormal notch measured 1.5 cm. in diameter on roentgenograms made with a 2 meter target-film distance. It was less well visualized in the left anterior oblique view. Pulsation could not be seen in the neighborhood of the indentation roentgenoscopically; and at esophagoscopy although the narrowing due to extrinsic pressure on the dorsal wall of the esophagus was obvious, pulsation was not observed.

The roentgen findings in this case are somewhat at variance with those in the few cases found in the literature up to the present. The indentation in the dorsal wall of the esophagus is smaller and is not best seen in the left anterior oblique view. The small convex shadow above the aortic knob on the left in the anterior view has not been described previously; in our opinion a lateral aneurysmal origin of an aberrant right subclavian artery satisfactorily accounts for this finding, and for the pulsations evident roentgenoscopically. According to our interpretation the esophageal impression in this case represents a segment of the circumference of the subclavian

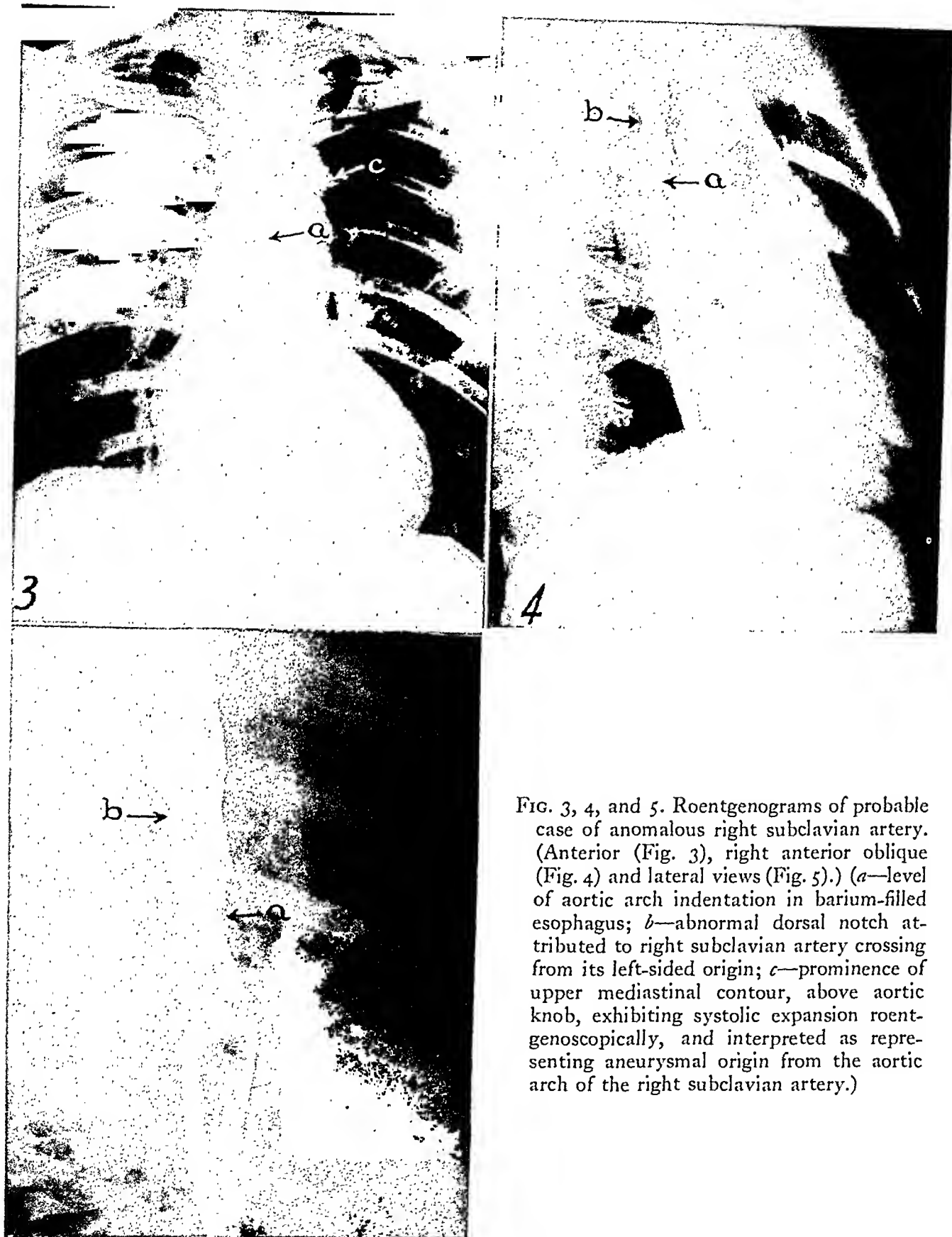


FIG. 3, 4, and 5. Roentgenograms of probable case of anomalous right subclavian artery. (Anterior (Fig. 3), right anterior oblique (Fig. 4) and lateral views (Fig. 5).) (*a*—level of aortic arch indentation in barium-filled esophagus; *b*—abnormal dorsal notch attributed to right subclavian artery crossing from its left-sided origin; *c*—prominence of upper mediastinal contour, above aortic knob, exhibiting systolic expansion roentgenoscopically, and interpreted as representing aneurysmal origin from the aortic arch of the right subclavian artery.)

artery proper, which is normal in caliber at this point due to the more lateral situation of the diverticular origin. Thus we postulate that in this case both the diverticulum-like origin and the esophageal imprint of

the anomalous subclavian artery itself are recognizable. While this vascular anomaly seems to best explain the roentgen features, other possibilities obviously exist. Extrinsic compression of the esophagus by a

lymph node was not excluded since pulsations could not be identified in the indentation; peripheral lymphadenopathy, however, was absent. The possibility seems remote that a mediastinal mass, not vascular, could be responsible for both the convex contour above the aortic knob and for the esophageal imprint. It will remain for future correlated roentgen and anatomic studies to prove whether or not the findings recorded above are characteristic of certain examples of left-sided origin of the right subclavian artery.

SUMMARY

1. Case report of a left-sided origin of right subclavian artery in a young man with vague symptoms of chest discomfort.

2. The diagnosis was based on roentgenoscopic and roentgenographic findings of: (a) indentation of dorsal wall of esophagus best seen in the left anterior oblique view; (b) a small convex prominence just above the shadow of the aortic knob in the anterior view in which there appeared intrinsic systolic pulsations.

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REFERENCES

1. ABBOTT, MAUDE E. Atlas of Congenital Cardiac Disease. Am. Heart Assoc., New York, 1936, pp. 16, 17 and 61.

2. ANSON, B. J. Anomalous right subclavian artery; its practical significance, with report of 3 cases. *Surg., Gynec. & Obst.*, 1936, 62, 708-711.
3. BAYFORD, D. An account of a singular case of obstructive deglutition. *Memoirs of the Medical Society of London*, 1789, 2, 271.
4. CAIRNEY, J. Anomalous right subclavian artery considered in light of recent findings in arterial development. *J. Anat.*, 1925, 59, 265.
5. CONGDON, E. D. Transformation of Aortic Arch System during the Development of the Human Embryo. Contributions to Embryology, No. 68. Carnegie Inst., Washington, Pub. No. 277. Pp. 47-110, 1922.
6. DAHM, M. Zur Eindellung der Speiseröhre bei links entspringenden Arteria subclavia dextra. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1940, 62, 108-114.
7. GÜNSEL, E. Dysphagia lusoria bei Arcus aortae dexter und sinister. *Röntgenpraxis*, 1940, 12, 346-348.
8. HARVEY, W. Notes on two cases of anomalous right subclavian artery. *Anat. Rec.*, 1917, 12, 329.
9. HOLZAPFEL, G. Ungewöhnlicher Ursprung und Verlauf der Arteria subclavia dextra. *Anat. Hefte*, 1899, 12, 369.
10. KOMMERELL, B. Verlagerung des Ösophagus durch eine abnorm verlaufende Arteria subclavia dextra (Arteria lusoria). *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1936, 54, 590-595.
11. ROESLER, H. Clinical Roentgenology of the Cardiovascular System. Second edition. Charles C Thomas, Springfield, Ill., 1943.
12. ZDANSKY, E. Die links entspringende Arteria subclavia dextra. In: *Röntgendiagnostik des Herzens und der grossen Gefässe*. J. Springer, Vienna, 1939, pp. 365-367.



SACCULAR ANEURYSM OF THE ABDOMINAL AORTA*

REPORT OF A CASE OF EIGHT YEARS' DURATION

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ANEURYSM of the abdominal aorta is about one-tenth as common as aneurysm of the first portion and the arch of the aorta. Not more than 600 cases have been reported (Hubeny and Pollack, and Scott). The disease is caused by weakening of the media by destruction of the elastic tissue. Syphilis is the most common cause but some cases are due to arteriosclerosis and infected emboli that lodge in the vasa vasorum. The disease is more common in the colored race.

Saccular aneurysm increases progressively in size, causing atrophy and erosion of any structure on which it impinges, including bony tissue. Thrombosis in successive layers occurs in the aneurysmal sac; this serves to strengthen the wall to some extent although there is but little organization of the thrombus. There is little direct effect on the heart or the circulation, and symptoms are usually due to the pressure and erosion of adjacent structures. The average time of observation of the reported cases was only a few months. Scott writes that 70 per cent succumbed within three years after onset of symptoms, that 17 per cent survived more than five years and that only 1 patient who did not have an erosion of the lumbar spine has survived for twenty-eight years.

The case we are reporting was observed for more than eight years.

P.H., white male, aged thirty-five, acquired syphilis at the age of seventeen. He had very little antiluetic treatment but had a negative blood Wassermann at the age of twenty-two. When seen in 1936 his Wassermann reaction was positive. In 1940, when an erosion of the lumbar spine was diagnosed for the first time, a brace was prescribed which enabled the patient to keep on working at rather strenuous

labor—he was employed in the construction of a Trans Isthmian Highway in the Panama Canal Zone. In June, 1941, on his way back to this country, his boat was torpedoed in the Caribbean Sea. While 32 of the crew were killed the patient, bruised about his chest, made his way down the ladder and into a life boat. He was picked up after drifting two days and two nights in the life boat and returned by plane. He continued working until October, 1943, when he fell from a truck, injuring his back. He was still able to walk when he was admitted to the hospital on February 5, 1944. He died of heart failure April 18, 1944.

Clinical Course. Slowly increasing backache, at first only intermittent, later on more or less continuously, localized in the area of the lower thoracic and upper lumbar spine and radiating into both legs. A palpable mass has been felt in the epigastric area since 1940, and has gradually increased in size. The skin in the epigastric area bulged and was of bluish discoloration. Bruit and thrill could be diagnosed over the tumor. Bending and erecting of the spine has been interfered with since 1940 but the patient could turn from one side to the other until shortly before his death. There was no gibbus. The function of the gastrointestinal tract remained normal.

Physical findings on admission to the hospital: A somewhat emaciated male, thirty-five years of age, who gave his normal weight as 165 lb.; present weight, 135 lb. Blood pressure 152/84. Fine tremor of the extended hands. Argyll Robertson pupils. Heart slightly accelerated, regular, considerable accentuation of the second pulmonic sound, loud systolic murmur at the apex. At intervals during the patient's treatment a pericardial friction rub was noted. The lungs were resonant at first but later during illness moist râles at both bases were heard. There was a palpable mass in the epigastrium over which there was a distinct bruit and thrill. Inguinal glands palpable but not markedly enlarged. The legs were at first

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thin but later became quite edematous. Knee jerks were slightly exaggerated.

The most impressive of the twenty-six roentgenograms taken of this patient during the time of observation are reported:

March 11, 1940 (Fig. 1): The lateral view shows an erosion on the anterior border of the first and second lumbar vertebrae, with the greatest destruction in the upper half of the body of the second lumbar.

January 6, 1942 (Fig. 2): In the anteroposterior view the opacity due to the aneurysm extends from the level of the left border of the tenth thoracic to the level of the left border of the first lumbar vertebra, bulging laterally, with its greatest width about 1 inch below the diaphragm. Distinct calcification in the upper third of the lateral wall of the aneurysm.

January 25, 1944 (Fig. 3 and 4): In the lateral view the erosion is more advanced and includes the bodies of the eleventh and twelfth thoracic and the first and second lumbar vertebrae. One-third of the eleventh thoracic, almost half of the twelfth thoracic and the first lumbar and the upper border of the second lumbar vertebrae are involved. In contrast to the increased destruction of the vertebral bodies the anteroposterior view shows that



FIG. 1. March 11, 1940.



FIG. 2. January 6, 1942.

the aneurysmal sac is smaller but that the calcification of its lateral wall is complete.

April 20, 1944 (Fig. 5 and 6): The first lumbar vertebra is almost completely destroyed, showing only a smaller upper and a larger lower triangle of bone structure on its posterior border, the findings in the eleventh and twelfth thoracic vertebrae are about the same as in the examination of January 25, 1944, but the destruction of the second lumbar vertebra is more advanced. The appearance suggests that the aneurysm has extended backward and downward (Fig. 5).

The roentgenogram of the chest, taken in the recumbent position shows the final stage of the disease: the right diaphragm is at the level of the fourth rib, the left diaphragm at the level of the sixth rib. There is some lack of translucency of the right lung and hyperaeration of the left lung, the heart is slightly displaced to the left side. No signs of pneumonia or bronchopneumonia shortly before death. The upward displacement of the right diaphragm is due to the pressure of the aneurysm from below (Fig. 6).

Autopsy Findings. Permission to examine the abdominal cavity only was obtained. This revealed a large saccular aneurysm of the ab-



FIG. 3 and 4. January 25, 1944.

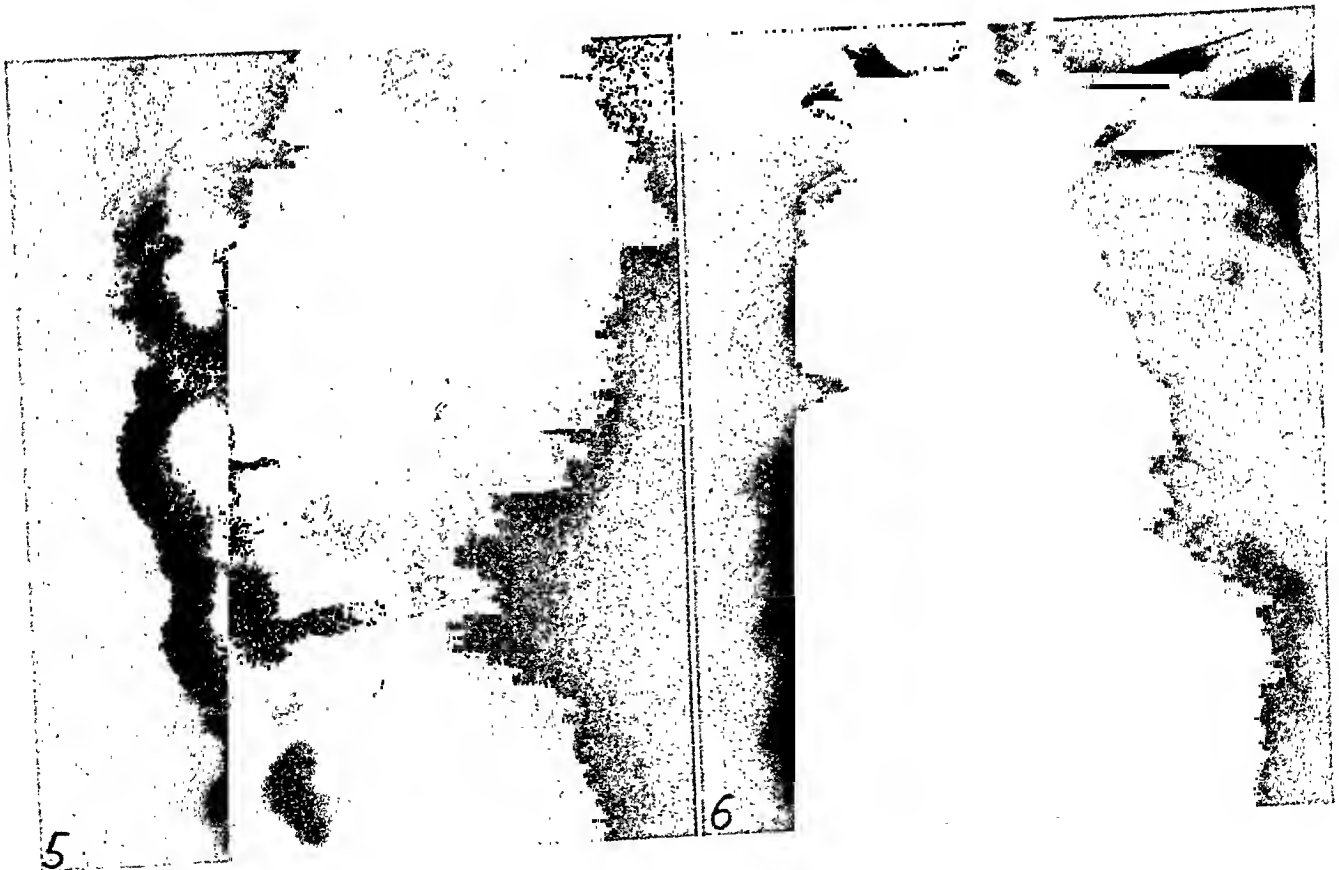


FIG. 5 and 6. April 20, 1944.

dominal aorta, 26 cm. long and 15 cm. in diameter, located in the right side of the abdominal cavity with the intestines displaced to the left side and the liver pushed up. The right diaphragm was at the level of the fourth rib, the left at the sixth rib. The sac of the aneurysm was not ruptured. There was complete erosion of the twelfth thoracic and the first lumbar vertebrae and partial erosion of the eleventh thoracic and second lumbar vertebrae. The wall of the abdominal aorta had considerable calcareous degeneration. The aneurysmal sac contained a large blood clot formed in laminated layers with practically no tendency to organization. There was considerable straw colored fluid in the abdominal cavity. The immediate cause of death was not due to the aneurysm but to congestive heart failure.

SUMMARY

A case of saccular aneurysm of the abdominal aorta, observed for eight years, is reported with clinical, roentgenological and pathological findings.

The typical roentgenographic findings were progressive erosion of four vertebral bodies and calcification of the wall of the aneurysm.

The case is of interest because the patient was able to work hard until a few months before his death and had survived torpedoing of his boat and drifting in the Caribbean Sea for two days and two nights.

We wish to thank Dr. Charles Gottlieb of New York University Medical College for having the prints of the negatives made in his department.

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REFERENCES

1. Abdominal aneurysms. Editorial. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 52, 664-665
2. DE LORIMIER, A. A. *The Arthropathies*. Year Book Publishers, Chicago, 1943, p. 308.
3. HUBENY, M. J., and POLLACK, S. Saccular abdominal aortic aneurysm. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 43, 385-393.
4. SCOTT, VIRGIL. Abdominal aneurysms. *Am. J. Syph., Gonorr. & Ven. Dis.*, 1944, 28, 682-710.
5. UNGER, A. S., and POPPEL, M. H. Aneurysm of the abdominal aorta. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1936, 36, 523-524.
6. WEINGROW, S. M., and BRAY, W. A. Aneurysm of the abdominal aorta. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1936, 36, 194-196.



HEPATODIAPHRAGMATIC INTERPOSITION OF THE COLON WITH GASTRIC HYPERTROPHY

CASE REPORT

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OUT of 20,000 roentgenoscopies, Kolju⁴ observed 29 patients with hepatodiaphragmatic interposition of the colon. Uspensky,⁹ in four and a half years, observed 22 such cases from among 26,000 colon studies. From these figures, a frequency of 1.1 cases per thousand is noted. This figure is in agreement with Lusena's assertion of 1 per thousand, quoted from Felkel.² Felkel believes the condition to be more frequent, but usually not recognized at the bedside.

Hepatodiaphragmatic interposition of the colon is primarily a roentgenological diagnosis. It manifests itself by the presence of a collection of gas in the right subdiaphragmatic space, interposed between the densities of both the liver and diaphragm. This roentgenographic finding has become so associated with the presence of intraperitoneal air following perforation of a viscus that the roentgenologist is momentarily perplexed when he notes this condition in a patient free of symptoms, much less the clinical findings suggestive of a perforated viscus. However, hepatodiaphragmatic interposition of the colon behaves just this way. Usually, it is discovered as an incidental finding on a routine examination.⁴ A case of this type is being reported. However, the main purpose of this paper is to call attention to the fact that gastric catarrh is the most common condition found associated with hepatodiaphragmatic interposition of the colon,⁴ and that this catarrh is the result of gastric hypertrophy secondary to pressure of the descended liver upon both the stomach and duodenum.

Pendergrass and Kirk⁵ reported a case of interposition of the hepatic flexure which upon the wet film was mistaken for free

gas in the peritoneum. The diagnosis of a ruptured viscus was made. At operation, an acute pancreatitis was found. Upon the dry roentgenograms the authors noticed for the first time thin haustrations traversing the gas and revised the diagnosis. Necropsy showed the liver to be rotated and low and the hepatic flexure interposed between the diaphragm and the liver. The case illustrates how an anomalous condition may closely simulate a serious surgical entity.

Schenck⁸ reported a case of a pinpoint perforation of the anterior surface of the pylorus (confirmed on laparotomy), in which the roentgenological diagnosis of a perforated viscus was rendered difficult by the concomitant existence of a hepatodiaphragmatic interposition of the colon. This latter condition was not recognized prior to operation. On reviewing the roentgenograms, Schenck noticed and called attention to the persistence of haustral markings and the unchanged appearance of the gas in the right subphrenic space in both the erect and prone views. These findings were indicative of hepatodiaphragmatic interposition. However, the presence of a distinct fluid level in the upright views would indicate that, in addition to the meteoric hepatic flexure, there were free air and fluid in the right subphrenic space. This case illustrates how an anomalous position of a bowel loop may exist concomitantly with an acute surgical condition, rendering roentgenologic diagnosis difficult.

The cases just cited serve to illustrate the importance and need of thorough knowledge of hepatodiaphragmatic interposition of the colon. Failure to recognize this entity leads to serious embarrassment. At any rate, in no case should surgical intervention be precluded because of the

presence of interposition, particularly when clinical findings indicate immediate laparotomy. Furthermore, the article by Schenck suggests a method of differentiating free gas from hepatodiaphragmatic interposition.

In the above, the disease entity, hepatodiaphragmatic interposition of the colon, has been considered primarily as an asymptomatic incidental finding. This is not always the case. Quite a large percentage of cases exhibit varied and uncharacteristic symptoms. Felkel² has reviewed the literature with particular reference to the symptoms occurring in this entity and has grouped them as follows:

I. Direct symptoms: those resulting from the displacement of the colon, and

II. Indirect symptoms: those due to pressure of the descended liver upon the neighboring organs.

Constipation and flatulence are most common of the direct symptom group. These may last several days finally to be relieved by the passage of massive stools and great quantities of gas. Kolju⁴ reports a case wherein a patient had only two normal bowel movements during a period of one and a half months. In the majority of the cases the constipation is of an intermittent nature. This is rather characteristic of interposition of the colon, particularly in the temporary, inconstant type of interposition of the colon (Uspensky,⁹ Podkaminsky⁶). Occasionally complete obstruction results through the inability of the peristalsis to further the fecal column and so necessitating cecostomy. Thus, in every case of intestinal obstruction following chronic constipation, interposition of the colon should be ruled out.

As for the indirect symptoms, dyspepsia, pyrosis, nausea, regurgitation, and vomiting are most common. At first glance, these symptoms seem unrelated to a disease entity in which a large bowel loop is interposed between the liver and the diaphragm. However, the downward and left displacement of the liver compresses the pyloric end of the stomach and the first portion of

the duodenum producing gastric retention, distention, eventual hypertrophy and possibly ulcerations. Thus, one should rather expect gastric symptoms in hepatodiaphragmatic interposition than be misled by them.

Podkaminsky⁶ and Sabat-Szczepansky⁷ assert that gastric ulcers appear as sequelae of interposition of the colon. This they explain on the basis of the above mentioned liver pressure upon both the pylorus and the duodenum. Also, Nicolich and Kayser,³ in their studies of cases of ectopic livers have frequently noted gastric ulcerations associated with liver ectopy.

Yet, Bürger¹ and Weiland¹⁰ uphold a view in direct opposition to that of the above investigators. These last mentioned maintain that the perforated gastric ulcer is the primary disease of which the interposition is a sequel. They proceed to explain that perforation of the ulcer results in an inflammatory adhesive process of the hepatoduodenal ligament which together with the weight of the ulcerated, distended stomach is sufficient to dislodge the liver from its cupola in the right cusp of the diaphragm. As a result, the hepatic flexure is permitted to interpose itself between the diaphragm and the liver.

In the above have been indicated the opposing views relative to the frequent association of interposition of the colon with gastric ulcerations. It is my opinion that both contentions are probably correct. However, the following case would favor the point of view which maintains that interposition of the colon is the primary lesion.

REPORT OF CASE

The patient, a white soldier in the early twenties, presented himself for a routine chest roentgenogram prior to his acceptance for Officers' Candidate School. On this roentgenogram (Fig. 1) large collections of gas were noted under both domes of the diaphragm. The soldier was immediately recalled for history and physical examination.

His past history revealed that he had been a lieutenant in the Polish Army during this war.

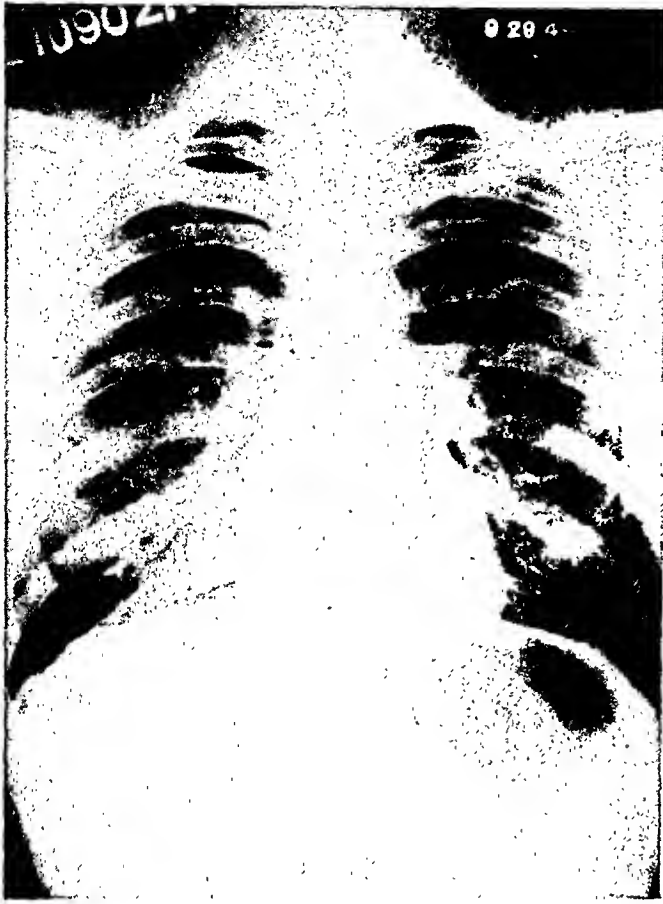


FIG. 1. Roentgenogram of the chest shows large collections of gas under both domes of the diaphragm. The gas collection on the right is out toward the periphery and it appears to be traversed by haustral markings.



FIG. 2. Barium enema, posteroanterior view, shows the distended hepatic flexure to be lateral, above, and in front of the liver. The splenic flexure is lower than usual with a large magenblase above it. The ascending and sigmoid colons are redundant.

When forced to flee to England in 1940, he had suffered severe exposure and malnutrition. He contracted pneumonia and was hospitalized in England. His condition was very critical, but he recovered after four months' treatment. As a child, he had had typhoid or typhus fever, he did not know which it was. Otherwise he had been absolutely healthy. There were no illnesses in his family.

At present, he is frequently disturbed by con-



FIG. 3. Barium enema, left oblique view, shows the distended hepatic flexure beneath the right dome of the diaphragm.

stipation and a feeling of being bloated. However, only on occasions does he resort to laxatives. He notes nothing peculiar about his stools. He has no abdominal pain but occasionally a sharp ache in his right shoulder. Off and on, he has a heartburn and gaseous eructations. He is able to eat all foods without discomfort. He believes that he has much more gas in his system than do other soldiers. Outside of this, he feels physically fit.

On physical examination the soldier is of medium build and well nourished. The head, eyes, ears, nose, and throat are negative. The chest examination shows the lungs and heart to be within normal limits. His abdomen is dome shaped, nontender, and tympanitic throughout. The liver and spleen are nonpalpable. No masses can be felt in the abdomen. One medical officer believes the abdominal cutaneous vessels to be prominent. There are no musculoskeletal abnormalities.

Roentgenoscopic and roentgenographic examination of the colon by barium clysma showed the hepatic flexure to be markedly distended and to lie above and in front of the liver, beneath the lateral half of the right dome of the diaphragm. The uppermost portion of the ascending colon was similarly dilated and lateral to the liver shadow. From this unusually high position, the hepatic flexure dipped abruptly downward to become continuous with the transverse colon. (According to Felkel,² the falciform ligament is the cause of this abrupt change in course.) The splenic flexure was at a much lower level than the hepatic flexure, beneath a rather large magenblase. This large gas-



FIG. 5. Barium enema, post-evacuation roentgenogram, shows the meteoric hepatic flexure.

tric air bubble may have caused the caudal displacement of the splenic flexure. Both the ascending and sigmoid colons were elongated and redundant but neither exhibited the degree of distention seen in the hepatic flexure. The remainder of the large bowel was characterized by moderate distention and an enormous capacity for contrast medium, almost three times the normal amount (Fig. 2, 3, 4, and 5). Upon the evacuation roentgenogram the large bowel was meteoric. The excursions of both domes of the diaphragm were equal.

The presence of the unusually large gastric air bubble on many of the roentgenograms suggested either an abnormality of the stomach itself or gastric dilatation, probably secondary to liver pressure upon the pylorus and duodenum. Roentgenological examination of the stomach and duodenum showed extrinsic pressure upon the lesser curvatures of both the stomach and duodenal cap, confirming liver ectopy (Fig. 6 and 7). Both the stomach and cap were markedly elongated and dilated. The mucosal folds were hypertrophic and the peristalsis quite active. From many of the roentgenograms the impression was gained that the liver was somewhat smaller than normal.



FIG. 4. Barium enema, right oblique view, shows the distended hepatic flexure beneath the outermost portion of the right dome of the diaphragm. Note the large magenblase.



FIG. 6. Roentgenogram shows distention and hypertrophy of both the stomach and the duodenal cap.

SUMMARY AND CONCLUSION

Hepatodiaphragmatic interposition of the colon is not a rare entity, and thus it attains sufficient importance so that its symptomatology, course, complications, differential diagnosis and treatment be gone into with greater thoroughness. Heretofore, investigators have concerned themselves primarily with its etiology and with the reporting of the entity as a rare and incidental finding. The author has included two case reports from the literature to illustrate how real and important the need for thorough familiarity with this entity can be. Next, the gastric symptoms, often found associated with hepatodiaphragmatic interposition, are elaborated upon. A special point is made of stressing the logical association between interposition of the colon and the presence of these gastric findings. The case herein reported is illustrative inasmuch as it demonstrates hepatic pressure upon a hypertrophic stomach.

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FIG. 7. Roentgenogram shows pressure along the lesser curvatures of both the stomach and duodenal cap.

REFERENCES

1. BÜRGER, M. Dystopia of liver. *Klin. Wchnschr.*, 1925, 4, 102-107.
2. FELKEL, R. K. Die chirurgische Bedeutung der Interpositio hepatodiaphragmatica coli. *Arch. f. klin. Chir.*, 1942, 203, 436-448.
3. KAYSER. *Deutsche Ztschr. f. Chir.*, 175, 411.
4. KOLJU, K. J. Roentgen diagnosis of hepatodiaphragmatic interposition of the large intestine. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1938, 39, 928-936.
5. PENDERGRASS, E. P., and KIRK, ELIZABETH. Significance of gas under the right dome of the diaphragm. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1929, 22, 238-246.
6. PODKAMINSKY, N. A. Zur Frage nach den Ursachen der Interposition von Organen zwischen Diaphragma und Leber. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1927, 36, 327-333.
7. SABAT-SZCZEPANSKY. *Jub. Kong. deutsch. Röntg.-Gesellsch.*, 1914.
8. SCHENCK, S. G. Collection of air in right subdiaphragmatic space, with special reference to hepatodiaphragmatic interposition of the colon. *Arch. Surg.*, 1938, 36, 766-777.
9. USPENSKY, A. Die pathogenetische Bedeutung des Symptomenkomplexes der "Interpositio Colonis." *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1928, 37, 540-555.
10. WEILAND. *München. med. Wchnschr.*, 1915, 62, 537.

MYELOGRAPHY IN PATIENTS WITH RUPTURED CERVICAL INTERVERTEBRAL DISCS*

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WITHIN the past two decades, myelography employing an opaque medium, has become a standard and well recognized roentgenographic procedure in the examination of the spinal canal. More recently, it has been established¹ that lateral rupture of the cervical intervertebral discs producing pain in the neck, shoulder and arm is a fairly common lesion. It is the purpose of this paper to present our experience with pantopaque myelography in patients having or suspected of having this condition.

Considerable diversity of opinion still exists in regard to the accuracy, or even the necessity of myelography in the diagnosis of ruptured disc in the cervical region. It is apparent that this question will remain unsolved until a large series of patients are subjected to both myelography and exploration, irrespective of the findings with myelography. To our knowledge such a series has not been reported as yet. However, it may safely be stated that with reference to the lumbar spinal canal, it is not an uncommon experience to obtain a negative myelogram in a patient who has all the signs and symptoms of a ruptured intervertebral disc. Furthermore, when these patients are explored a definite herniated nucleus has often been found. We have in our series of lumbar myelographies a sufficient number of such instances to justify the conclusion that a negative lumbar myelogram is merely inconclusive and does not rule out the presence of a herniated nucleus pulposus.

There is little literature on the subject of myelography in the diagnosis of ruptured discs in the cervical region. Spurling and Scoville² were the first to report a signifi-

cant series of cases. They concluded that myelography is an exceedingly accurate method of diagnosing these lesions and cited 11 cases proved at operation with only 1 normal myelogram in the group. Unfortunately, no mention was made as to whether there were any negative explorations in patients in whom a defect had been visualized in the myelogram. Michelsen and Mixer³ reported 8 cases of rupture of cervical discs, 7 of which had had myelography. In 1, the myelogram was negative; in 2 it was unsatisfactory; and in 4, the results were only suggestive. No conclusions concerning the accuracy of this procedure were offered. Epstein and Davidoff⁴ reported 5 cases of ruptured cervical intervertebral discs, in all of which the herniated nucleus pulposus produced spinal cord symptoms of varying degree. These lesions are usually much larger than those producing nerve root pressure alone; they are located in the center or at least near the central portion of the canal and result in myelographic defects differing from those that are the subject of our paper. Browder and Watson⁵ have recently reported on a series of 21 operated cases with an excellent clinicopathologic study. Their cases have included disturbances of the disc causing pressure on the nerve root and/or spinal cord. They state that they had been able to collect only 69 verified cases. Our experience is based on 62 cervical myelograms, 28 of which were positive, with 16 verified at operation.

Lateral herniation of the cervical intervertebral disc may result from slight or severe trauma or it may appear without any recognizable injury. These lesions have been classified into two types: the soft ex-

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truded nodule of nucleus pulposus which may later undergo degeneration and calcification and when calcified is often wrongly interpreted as an arthritic spur; and protrusions of the disc without rupture of the annulus fibrosus or extrusion of the nucleus. Calcification may occur in the late stage of this second type also.

The symptoms vary greatly in intensity. Usually there is some pain and stiffness in the neck with radiation down the medial border of the scapula, the shoulder, the anterior chest, the lateral and medial borders of the arm and forearm to the hand. Weakness of the hand and numbness and paresthesia in the thumb or one or more fingers may be present. As in the patient with rupture of a lumbar intervertebral disc, straining, coughing and sneezing aggravate the pain. Examination reveals muscle spasm and limitation of motion of the neck. There is some degree of scoliosis of the cervical spine, usually away from the lesion. Tenderness over the brachial plexus and scalenus anticus muscles may be elicited. Pressure on top of the head, described by Spurling and Scoville,² reproduces the pain. This may be accomplished also by pressure over the emerging nerve root. Motor, sensory and reflex changes may be present in the arm.

Actually in most cases the clinical findings permit of a high degree of accuracy in the localization of the lesion. In a significant number of cases, however, there are no findings upon which to base a neurologic localization.

The spinal fluid examination is of relatively little value in diagnosis of lateral herniations. Occasionally, however, there may be an increase in the total protein content.

The indications for cervical myelography in ruptured intervertebral discs are not yet clear. At the O'Reilly General Hospital, it has been our policy since late 1943 to do myelograms upon all cases suspected of having a ruptured cervical disc, provided that severe enough symptoms and signs have been present to warrant operation or

if an exact diagnosis was necessary for other reasons. This latter group has included several patients diagnosed as having coronary artery disease. In addition, the following are being subjected to myelography: all patients with the so-called scalenus anticus syndrome; patients with radiating pain in the arm associated with cervical rib; patients who have paralysis in an upper extremity due to involvement of one or more nerve roots; and those with indeterminate radiating pain in an upper extremity. It is freely admitted that in many cases, particularly those with the typical syndrome, myelography was not necessary to determine either the presence or localization of a ruptured disc. Yet, an occasional patient may show a ruptured disc which is impossible to demonstrate by any other method.

TECHNIQUE

We consider pantopaque (ethyl iodophenylundecylate) to be the opaque medium of choice. At body temperature it is one-seventeenth as viscid as the iodized poppy seed oils. For this reason it is more easily injected and removed, is less prone to globulation and, most important, it assumes more accurately the shape of the subarachnoid space. It has a further advantage in that any portion which cannot be aspirated will be absorbed. Its more rapid movement has not proved a disadvantage in either the lumbar or cervical regions because in both of these regions the spinal curve in the prone patient is concave upward and motion of the oil can be exactly controlled by the degree and speed of table tilt. (In the dorsal region, which is concave downward, the amount and rapidity of flow cannot be thus well controlled and a more viscid medium might therefore be more desirable for dorsal myelography.)

The injection is made with aseptic technique. The operator is dressed as for any surgical procedure, wearing cap, mask, sterile gown and sterile gloves. The roentgenologist, technicians and patient wear masks. With the patient lying on his side

the spinal puncture is performed between the fifth lumbar and first sacral segments. Some prefer the third or fourth lumbar interspace. When a free flow of fluid has been obtained the patient slowly straightens out his legs and turns over into the prone position. He is draped with a perforated spinal puncture sheet and manometric studies are done to demonstrate by free rise and fall of fluid on cough and Queckenstedt maneuver that a satisfactory tap has been obtained. If a free motion of fluid in the manometer cannot be obtained by manipulation of the needle a preliminary injection of 1 cc. of opaque medium is done and its movement on coughing and on tilting the table is studied roentgenoscopically to confirm its subarachnoid location before the remainder of pantopaque is injected. This precaution is taken to avoid the difficulties which occur in trying to obtain a satisfactory tap and satisfactory roentgenoscopic visualization after a substantial epidural injection has inadvertently been made. If blood is obtained in the subarachnoid space the procedure is delayed ten days. (In one instance an accidental intravenous injection was made in this hospital; the patient did not develop any untoward symptoms.)

After confirming the establishment of a satisfactory tap either by manometric studies or by the observation of a small preliminary injection, the operator completes the injection of 6 cc. of opaque material. This is done with the table tilted as much as may be necessary to bring the tip of the needle to the lowest point of the lumbar curve. This insures that the opaque material will directly enter a pool as it leaves the needle, rather than becoming globulated by descending in a series of drops from the needle tip to a pool some distance cephalad or caudad.

For cervical myelography the patient's head is placed toward the end of the table which can be tilted the lowest and the body supported by a shoulder rest. The patient's neck is hyperextended so that the face is looking directly forward. A thickly folded

sheet is placed under the chin to maintain this position during the initial procedure of tilting the table until the oil has shifted to the cervical region. The table tilt is increased slowly until the oil begins to spill over the dorsal curve and run into the cervical region. The first entry of the oil into the cervical area is often very informative and is closely observed. After all the oil has entered the cervical region the table is brought back nearly to the horizontal. From this point on an extreme table tilt will not be necessary and there is therefore less danger of flow of oil into the intracranial cisterns from which it cannot always be recovered. The marked hyperextension of the neck is therefore no longer necessary and is reduced in order to remove as far as possible, the shadow of the occiput on the upper cervical spine.

Roentgenoscopic examination is then made in the frontal position while the table is varied to bring the oil into the various levels of the neck. The fourth cervical to first dorsal levels are checked with special care as they include the frequent sites of nucleus pulposus protrusion. The contour of the column is observed when each region is filled with opaque medium. The behavior of the oil as it enters and leaves the region is also closely studied as the minimal recognizable lesions will be indicated only by a delay in flow or deviation in the direction of flow of the entering or exiting oil and by a thinness, demonstrable only when the region is partially filled, of the oily layer over the lesion.

Pertinent exposures are made with spot film apparatus in frontal and oblique positions, since occasionally defects can be detected in the oblique views which do not show in the anteroposterior projection. This is particularly true of small central lesions. Roentgenoscopy and roentgenography in the lateral projection have not, in our experience, added any information. The films are developed immediately and studied in conjunction with the roentgenoscopy until a satisfactory study of all suspected abnormalities has been made.

The examination is then complete. In order to return the oil to the lumbar region it is necessary to reverse the patient on the table so that the feet will be at the end which descends lowest. The patient's head is manually supported in moderate hyperextension while this maneuver is done. With the table tilted to a nearly upright position the patient coughs and turns his head several times to dislodge as much oil from the nerve root sheaths as possible. The table is then returned toward the horizontal until the oil rests beneath the needle when it is aspirated. Some difficulty may be experienced in obtaining the last 0.5 cc. of oil, but with rotation of the patient and change of level of the opaque medium under roentgenoscopic control this can nearly always be accomplished. The needle is withdrawn and the patient returned to the ward where he is kept flat in bed for forty-eight hours to minimize headache. During this period 1 gram of sulfadiazine and 2 grams of sodium bicarbonate are given every four hours.

It has been noted that approximately 5 per cent of the patients develop some stiffness of the neck after myelography and this may last for seventy-two hours. However, with one exception, this has not been an indication of infection. It is probably associated with an inflammatory response of the meninges due to the slight irritative effect of the opaque medium.

ROENTGENOLOGIC INTERPRETATION

The importance of preliminary examination of the cervical spine cannot be too greatly stressed; when the findings on this examination are correlated with the clinical history they are quite significant. Positive findings appear to be proportionately more frequent in this portion of the spinal column than in the lumbar; this we believe to be due to the anatomical differences present. To detect abnormalities it may be necessary to expose films in anteroposterior, lateral and stereoscopic oblique projections. However, it must be noted that a ruptured cervical disc may be present and produce severe symptoms without demon-

strable abnormality on the plain roentgenograms.

The changes on the plain roentgenograms were first described by Semmes and Murphey.¹ The following abnormalities should be looked for: (a) scoliosis; (b) straightening or reversal of normal cervical curve, either complete or segmental; (c) calcification in the posterior joint space; (d) encroachment of the intervertebral foramen by soft tissue shadow and/or osteophyte; (e) localized arthrosis.

The frequency of the occurrence of changes on the plain roentgenograms is illustrated in Table I, which shows that for our series 18, or 69 per cent, of 26 patients with a disc on roentgen examination had a

TABLE I
CERVICAL MYELOGRAPHY
(January 1, 1943-July 1, 1945)

	Num- ber	Per Cent
Myelograms	62	
Positive for disc	28	45
Plain films taken	26	
Abnormality on plain films	23	88
Reverse or straightened curvature	18	69
Negative for disc	34	55
Plain films taken	31	
Abnormality on plain films	16*	52
Reverse or straightened curvature	9	30

* Includes 4 patients with fusion, 2 with arthrosis and 1 with old compression fracture.

reversed or straightened curvature. For those without a disc the corresponding percentage is 30. The higher incidence in the former is apparent.

So that these figures may not be misleading it should be stated here that there are many other conditions of the cervical spine which can cause an abnormal curvature and which are far more common. Among these are injuries such as sprains and partial dislocations to which this segment of the spinal column is particularly susceptible. Nerve root irritation due to causes other

than pressure from a herniated nucleus is also far more frequent. The point to be made is that the finding of an abnormal curvature should lead one to suspect the presence of a ruptured disc.

It may be of value at this point to digress and discuss the relationship of localized hypertrophic arthritis (arthrosis) in the cervical spine to ruptured cervical discs. Roentgenologists have for many years described these lesions. Their interpretation, however, has not always been correct. It is our opinion that these changes in a significant number of cases are the result of injury to the disc, thereby constituting a traumatic rather than hypertrophic or degenerative arthritis. This opinion is supported by the work of Keyes and Compere⁶ who have proved experimentally that injury to the intervertebral disc is followed by spur formation along the margins of the adjacent vertebral bodies. Localized spur formation is more common in the two divisions of the spinal column subject to the greatest stress, namely the lower cervical and the lower lumbar areas. It is not merely a coincidence that these sites are likewise the location of the great majority of ruptured discs. In addition, herniated nucleus pulposus material has been found in the center of these so-called hard nodules or arthritic spurs. One of us (F. M.) has also seen spurs develop on the vertebra adjacent to the ruptured disc in the cervical and lumbar regions both before and after operation. Oppenheimer⁷ states that disc rupture and Hadley⁸ believes that narrowing of the joint space (which no doubt occurs sooner or later in most herniations of nucleus) are factors in the production of localized arthrosis.

Although preliminary roentgen examination gives adequate information about the intervertebral joint space, from a roentgenologic standpoint the myelogram is in most cases necessary in demonstrating the presence of protrusion or herniation of the nucleus pulposus. In myelography, roentgenoscopic and roentgenographic observation are of equal importance. Deviation in

direction of flow and delay are purely roentgenoscopic findings while filling defects of the subarachnoid space are visualized both on roentgenoscopy and on the roentgenogram.

When the lesion is situated laterally the defect is triangular with a distinct lower border; more often, however, it is hemispherical. It is usually located at the level of the joint and is occasionally best seen with the occiput rotated toward the side opposite the lesion. The cuff of the nerve root pouch may be blunted or entirely obliterated. Occasionally it may be displaced caudally, resulting in a change in the angle of exit of the nerve. One may rarely find a widening of the caliber of the nerve root which is interpreted as edema. Just as infrequently one finds a large unilateral lesion which is exerting pressure on the subarachnoid portion of the subjacent cervical nerve root displacing it medially.

The midline lesions are visualized by a round or irregular "gap" defect at the level of the joint and are best seen in the frontal projection with only partial filling of the level at which they are situated. At roentgenoscopy it is this lesion which may first become apparent as a translucency of the central portion of the column of opaque medium. In the larger central lesion the column of opaque medium assumes a "U" or "L" configuration as it flows past the obstruction. This is the type of lesion which is most apt to cause greatest damage to the spinal cord although the lateral lesion if large enough will also compress the cord.

In the interpretation of the myelograms it has been wiser to describe the abnormality as a defect. One can on occasions differentiate between protrusion of the disc and herniation of the nucleus pulposus but it is felt that this differentiation can only be made with certainty at operation. Likewise it is hazardous to differentiate a hard from a soft lesion unless calcium in the foramen is conclusively visualized. The defect may be small or large, smooth or irregular. It may be well defined or poorly circumscribed as in those large lesions causing

compression of the spinal cord. Four types of lesions were most common roentgenographically in this series:

- 1. The shallow "half-moon" defect with an irregular or smooth base. The nerve root may be broadened or it may be entirely obliterated. Occasionally either the superies or the inferior cuff may be effaced.
- 2. The triangular-shaped defect with a clear-cut lower border and less distinct upper border. The root sleeve is usually obliterated.
- 3. The poorly circumscribed "pressure" defect due to compression of the spinal cord with obliteration of the nerve root. This defect may be large or small.
- 4. The large irregular "gap" defect sometimes extending to the midline. The nerve root is deformed or obliterated and there is a narrowing of the lateral column of dye.

CORRELATION OF ROENTGENOGRAPHIC AND OPERATIVE FINDINGS

It has been stated above that an accurate clinical diagnosis of a ruptured disc can

TABLE II

	Myelo-gram	Myelo-gram
	positive	negative
Operation with positive results	17*	0
Operation with negative results	0	3
No operation	11	31
	—	—
Total	28	34

* Includes one recurrence.

be made in a large percentage of patients without recourse to myelography. It would be desirable to know just how accurate myelography is in those patients where the clinical diagnosis is obscure or uncertain. Again this could only be answered by exploration of all patients having undergone myelography irrespective of the myelographic finding. Here, it can be affirmed without reservation that in our series a perfect correlation existed in that a herniation or protrusion was found in every patient

operated upon because of nerve root pressure and positive myelographic findings. In addition, 3 other patients suspected of having a disc clinically but with negative myelograms were explored without finding a disturbance of the disc (Table II). It must again be emphasized that this high degree of accuracy in roentgen diagnosis was possible only by correlating the clinical findings with the myelographic result. Several patients had multiple defects but no attempt was made to confirm them at operation unless there was clinical evidence of pressure on the nerve root. Since not all patients in this series having negative myelograms were operated upon, the diagnostic value of the negative myelogram has not been completely determined; yet it seems justifiable to conclude from the evidence thus far that the negative cervical myelogram bears more weight than the negative lumbar myelogram.

DISTRIBUTION OF LESIONS OBSERVED MYELOGRAPHICALLY

While it has not been possible to confirm by operation the presence of all defects described on roentgen examination it would

TABLE III

	Cases	Per Cent
A. Side		
Right	21	56
Left	17	44
	—	—
Total	38	100
B. Level		
C-3	2	5
C-4	1	2
C-5	12	32
C-6	21	56
C-7	2	5
	—	—
Total	38	100
C. Number of lesions per patient		
Single lesion	18	66
Bilateral at one level	5	19
Multiple levels	5	15
	—	—
Total	27	100

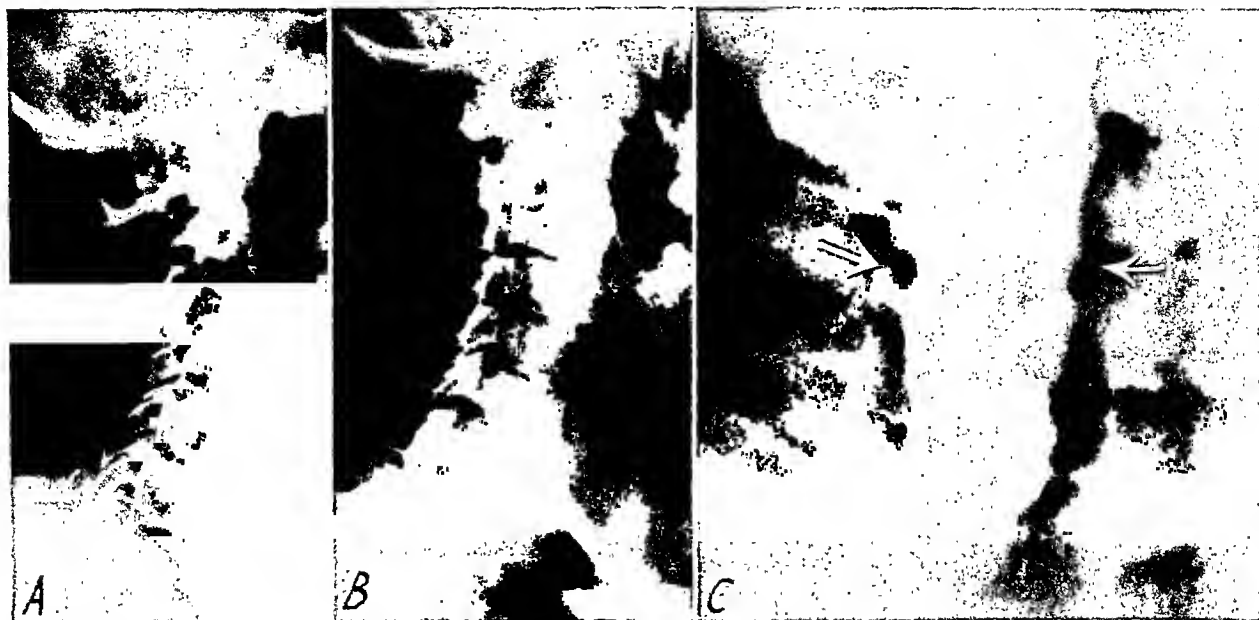


FIG. 1. Case I. (A) straightening of cervical curve in lower half, narrowing and posterior spurring of joint space between C-6 and C-7. (B) encroachment of foramina on left at levels of C-4, C-5 and C-6. (C) bilateral shallow smooth defect at C-6 with flattening of root sleeves.

still be of interest to tabulate the distribution of the lesions in our series. The accuracy of any series of course would be higher, the fewer the examiners and the greater their experience. It is evident in Table III that there is a preponderance of single lesions (66 per cent); that they are fairly evenly divided between the right and left sides and that the most frequent sites are at the levels of the sixth cervical and the fifth cervical (88 per cent). The latter finding confirms the observation that the lower cervical spine is the point of greatest stress so much so that it has been described as the handle of a whip.

ILLUSTRATIVE CASE REPORTS

CASE I. An Army nurse, aged twenty-two, on May 30, 1944, began to have pain in the left shoulder which radiated along the outer aspect of the arm, forearm and into index and middle fingers of the left hand. Physical therapy in the out-patient department giving no relief, she was hospitalized in June, 1944. Past history shows that she was thrown from a horse in childhood and had a stiff neck for two weeks. On physical examination there was marked tenderness over the scalenus anticus muscle at the level of the sixth transverse process, decrease in the left triceps reflex and hypesthesia in the

left index and middle fingers. Roentgen findings are shown in Figure 1, A, B, and C. A left subtotal hemilaminectomy was done and a protrusion of the disc without rupture was noted at the level of C-6. The seventh cervical root was decompressed. Following operation the patient had a complete relief of symptoms.

CASE II. A soldier, aged twenty-seven, in March, 1944, while doing calisthenics developed pain in the posterior neck associated with a shock-like tingling in the whole body. Stiffness in all extremities and pain in the left elbow were also noted. He was transferred from a station hospital to O'Reilly General Hospital with a diagnosis of cord tumor. On physical examination there was a mild spasticity of the upper and lower extremities, diminution of deep sensibility, and diminished vibratory sense. Reflexes were increased. A lumbar puncture showed partial block and increased protein. Roentgen findings are shown in Figure 2, A, B, and C. A laminectomy was done from C-3 to C-6 and many fragments of herniated nucleus pulposus were removed. There was a disappearance of the pain in the left upper extremity and gradual improvement in the quadriplegia.

CASE III. An officer, aged thirty-four, in July, 1942, while overseas, noted an occasional sharp stabbing pain at the base of the neck with radiation under the right scapula. On Decem-

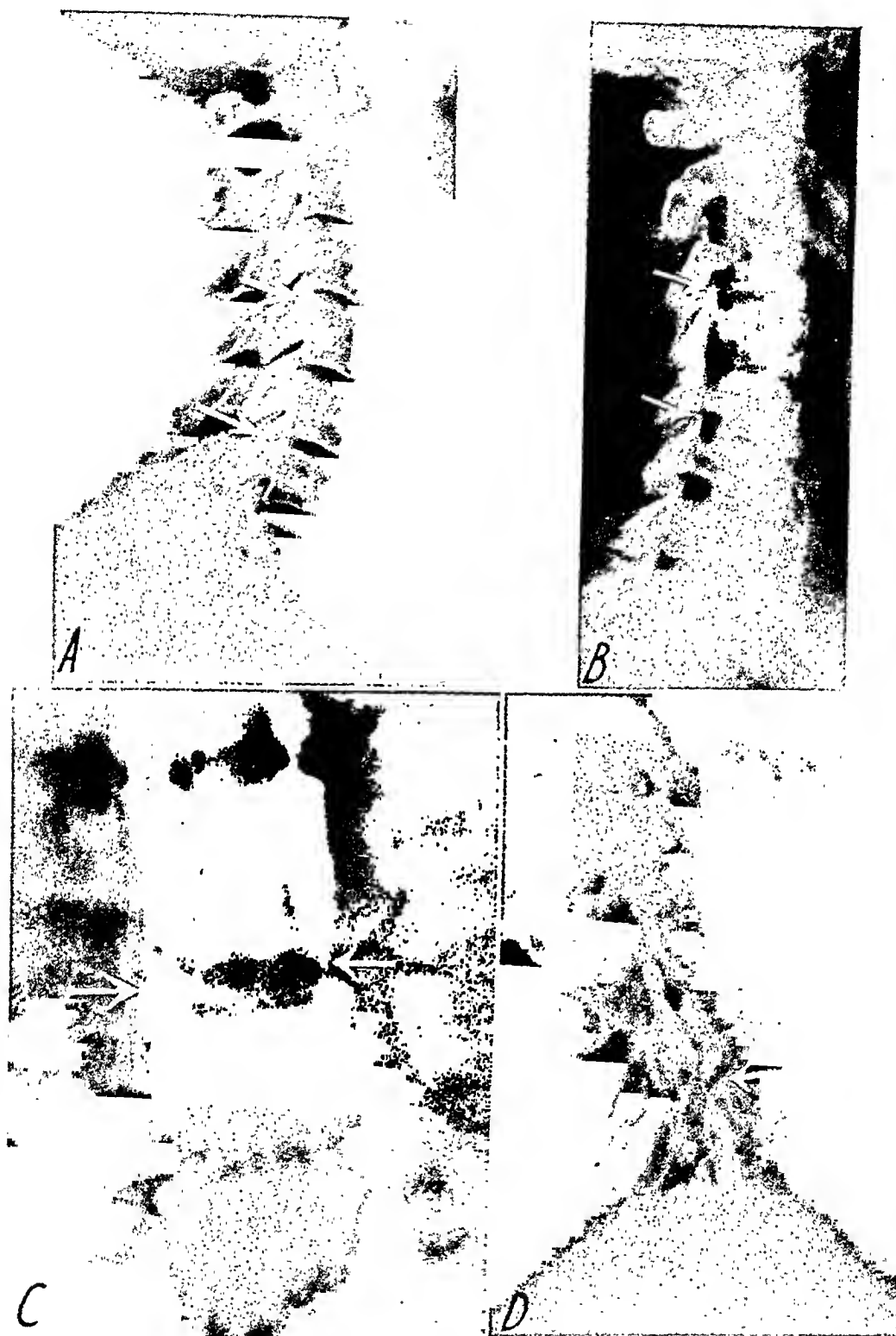


FIG. 2. Case II. (A) narrowed space and marked posterior spurring of joints between C-3 and C-4 and C-5 and C-6. (B) encroachment of foramina at C-3 and C-5, left. (C) bilateral shallow irregular defect at C-5, with widening of root cuff. (D) block in column of dye at C-3.

ber 25, 1942, he awakened with a stiff neck. Physical therapy seem to alleviate the pain and he continued on duty until February, 1943, when he developed a burning pain in the right side of his neck. A brachial plexus block with procaine was done without relief. He was then sent back to the United States. On arrival the

pain radiated down the outer right forearm and into the thumb and index finger. Coughing, sneezing and straining aggravated this pain. At one general hospital the spines at C-7 and T-1 were removed without relief, but subsequent bed rest improved his symptoms. In October, 1943, he had a recurrence and was transferred

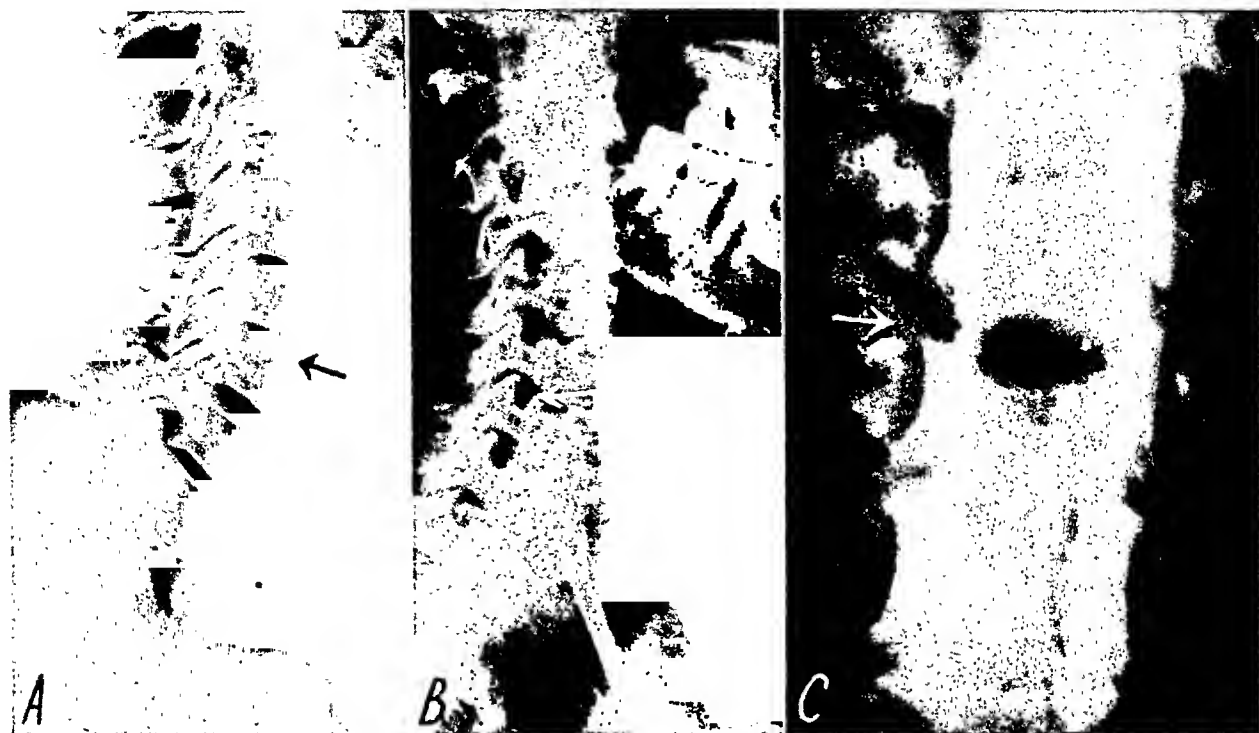


FIG. 3. Case III. (A) posterior spur formation especially marked between C-5 and C-6. No loss of curvature. (B) encroachment of foramen on right between C-5 and C-6. (C) small shallow irregular "half-moon" defect impinging on nerve root at C-5 on right.

to O'Reilly General Hospital. On physical examination there was a midline scar over the lower cervical and upper thoracic regions. There was percussion tenderness over C-6; rotation and compression of the neck reproduced this pain. The right biceps jerk was decreased. Roentgen findings are shown in Figure 3, A, B, and C. Patient refused surgery; treatment in the form of traction, physical therapy and bed rest was given. There was no improvement but the officer returned to duty, and still continues to have the same symptoms though less severe.

CASE IV. A soldier, aged twenty-five, on November 12, 1943, received a gunshot wound of the right leg, which was treated in a general hospital in Australia. While under treatment the patient developed "smothering" spells which were associated with a constricting sensation in left lower chest. He also had some left arm and forearm pain. After transfer to the O'Reilly General Hospital and while on furlough his condition was aggravated. The neuropsychiatric consultant felt that although an anxiety state existed there was an organic basis for his difficulty. On physical examination there were no significant findings but the history suggested a herniated disc as all other laboratory

tests and electrocardiogram were negative. Roentgen findings are shown in Figure 4, A and B. Treatment was conservative with reassurance as to the heart. Signs and symptoms were too mild to justify surgery. Improvement resulted.

CASE V. An officer, aged thirty-five, in February, 1944, was carrying an 80 pound pack on his back and pulling a sled for a period of thirty-six hours when he developed a pain in the right shoulder, inner side of arm and forearm and a blanching of his ring and little fingers. Novocaine was injected in the brachial plexus region with marked relief. However, arm and forearm ache persisted for four months. In July, 1944, he had severe recurrence and was given thiamin chloride and heat without relief. In December, 1944, a private physician found a narrowed joint space between C-6 and C-7. In late December left upper extremity pain appeared after the pain on the right had ceased. This new pain was associated with a stiff neck and was aggravated by coughing and sneezing. He was admitted to the O'Reilly General Hospital with a diagnosis of brachial neuritis. On physical examination there was marked spasm of the left neck muscles with elevation of the



FIG. 4. Case IV. (A) reversal of normal anterior curve. (B) bilateral minimal smooth defect between C-6 and C-7 segments.

shoulder. Pressure on the head and rotation of the neck reproduced the pain. Rotation of the neck and flexion was limited and the left biceps jerk was reduced. Roentgen findings are shown

in Figure 5. A, B and C. A subtotal laminectomy between C-6 and C-7 on the left was done with removal of a herniated nucleus pulposus. The pain and muscle spasm were relieved. The

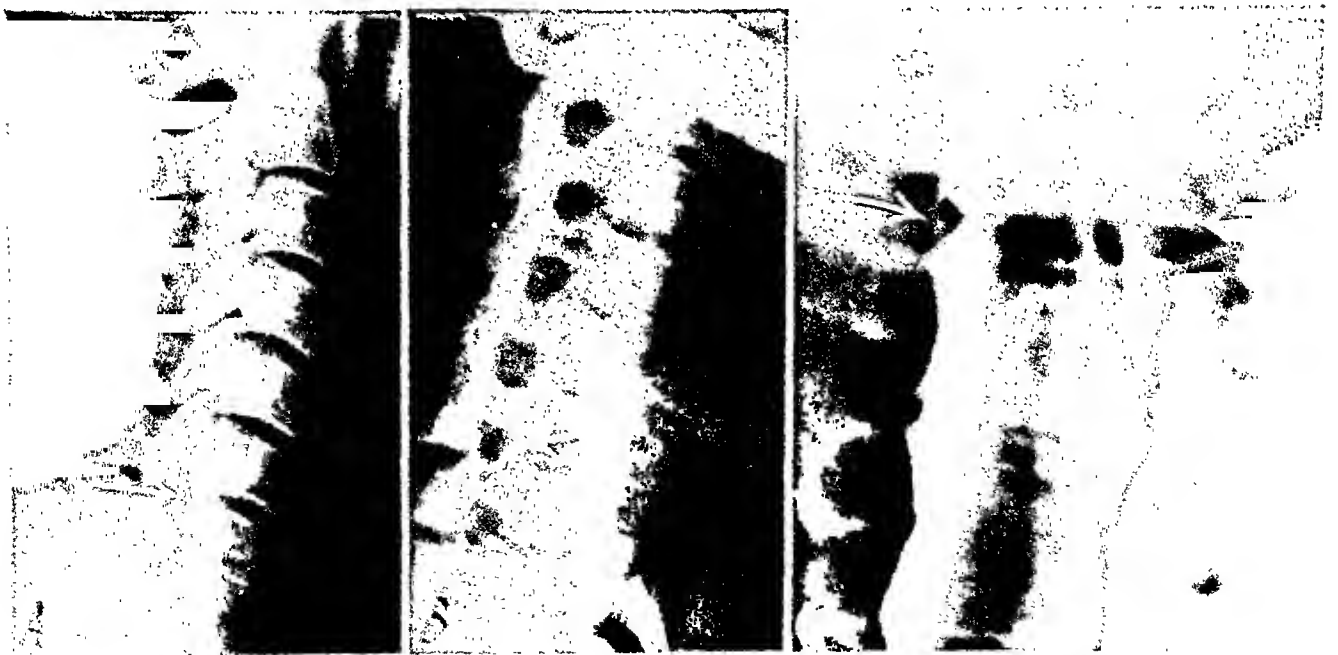


FIG. 5. Case V. (A) straightening of lower cervical spine; narrowed space and posterior spurring of joint space between C-6 and C-7. (B) enlargement of foramen between C-6 and C-7 on left. (C) bilateral shallow irregular defect more marked on left and obliterating nerve root at level of C-6. Edema of spinal portion of subadjacent nerve root.

left shoulder assumed a normal posture, about two months after surgery. However, three months after surgery patient developed some precordial pain and a hot spot under left scapula, which was relieved by traction; this may be a recurrence.

CASE VI. An officer, aged thirty-five, in August, 1944, developed pain in the right shoulder with radiation down the outer aspect of the arm and dorsal aspect of forearm, lasting one week. In October, 1944, patient developed a stiff neck followed by a recurrence of the above arm and forearm pain. He went on leave, took a 2,000

grams showed that the previously noted calcification in the foramen had been removed.

CASE VII. A soldier, aged thirty-five, while lifting a heavy piano in January, 1945, suddenly felt a pain in the base of his neck. Within two days he had radiation of the pain in his left shoulder, the outer side of the left arm, forearm and into the index and middle fingers. Rather marked precordial pain was also present intermittently; this concerned him the most. He received conservative therapy in the form of heat and massage without any relief of symptoms and was eventually transferred to O'Reilly Gen-

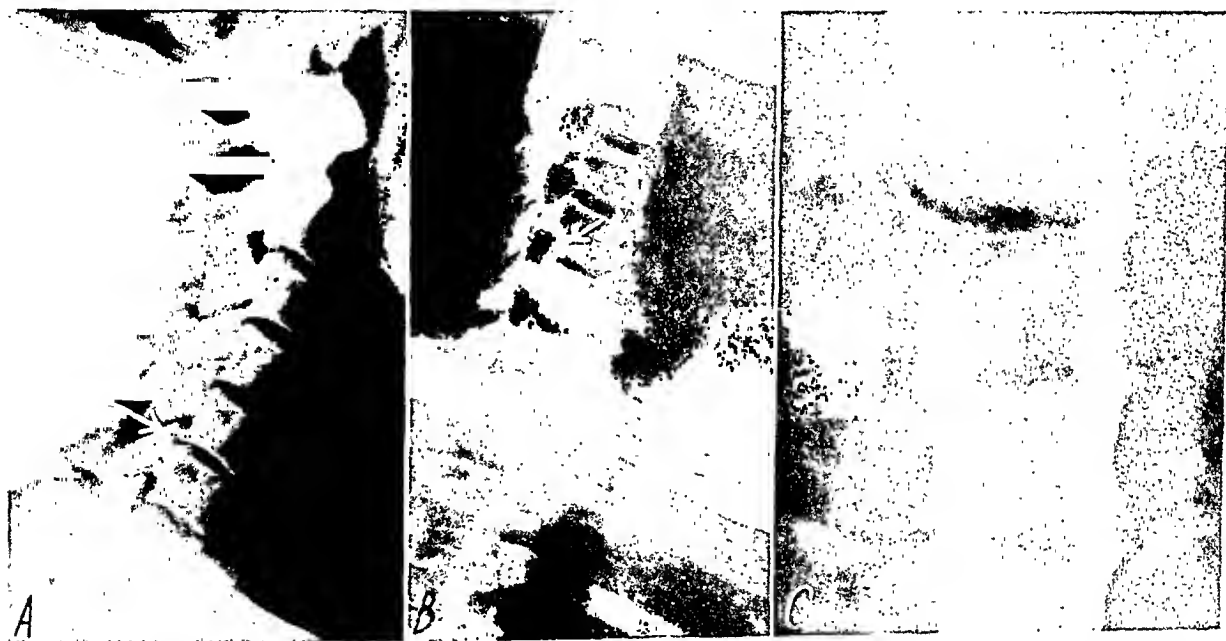


FIG. 6. Case vi. (A) narrowed joint space and posterior spurring between C-5 and C-6. (B) encroachment of foramen by calcium shadow between C-5 and C-6 on right. (C) large poorly circumscribed pressure defect obliterating nerve root at C-5, right.

mile train trip and on arrival had to have a narcotic to relieve this pain. He also noted that if he rotated his head and neck into one position or raised and abducted his arm, pain would be relieved. On physical examination there was limitation of motion in the neck, point tenderness over sixth cervical transverse process, weakness in the right hand, and hypesthesia of the right thumb. The right biceps and radio-periosteal reflexes were reduced. Roentgen findings are shown in Figure 6, A, B and C. A subtotal laminectomy at C-5 was done and fragments of herniated nucleus pulposus were removed. The pain was entirely relieved but the patient had some residual numbness in the tip of the right thumb. Postoperative roentgeno-

grams showed that the previously noted calcification in the foramen had been removed. His symptoms were greatly aggravated by the train ride. On physical examination there was slight general atrophy in the left upper extremity, a loss of the left triceps reflex and some weakness in the left grip. Pressure over the left sixth transverse process produced severe pain radiating into the arm, forearm and hand. Gentle compression and rotation of the head to the left markedly aggravated the patient's symptoms, reproducing particularly the precordial pain. There was hypesthesia in the index finger. For roentgen findings, see Figure 7, A and B. On July 3, 1945, a left subtotal laminectomy was done and a large herniated nucleus pulposus was found anterior to the seventh cervical root. This was removed; during

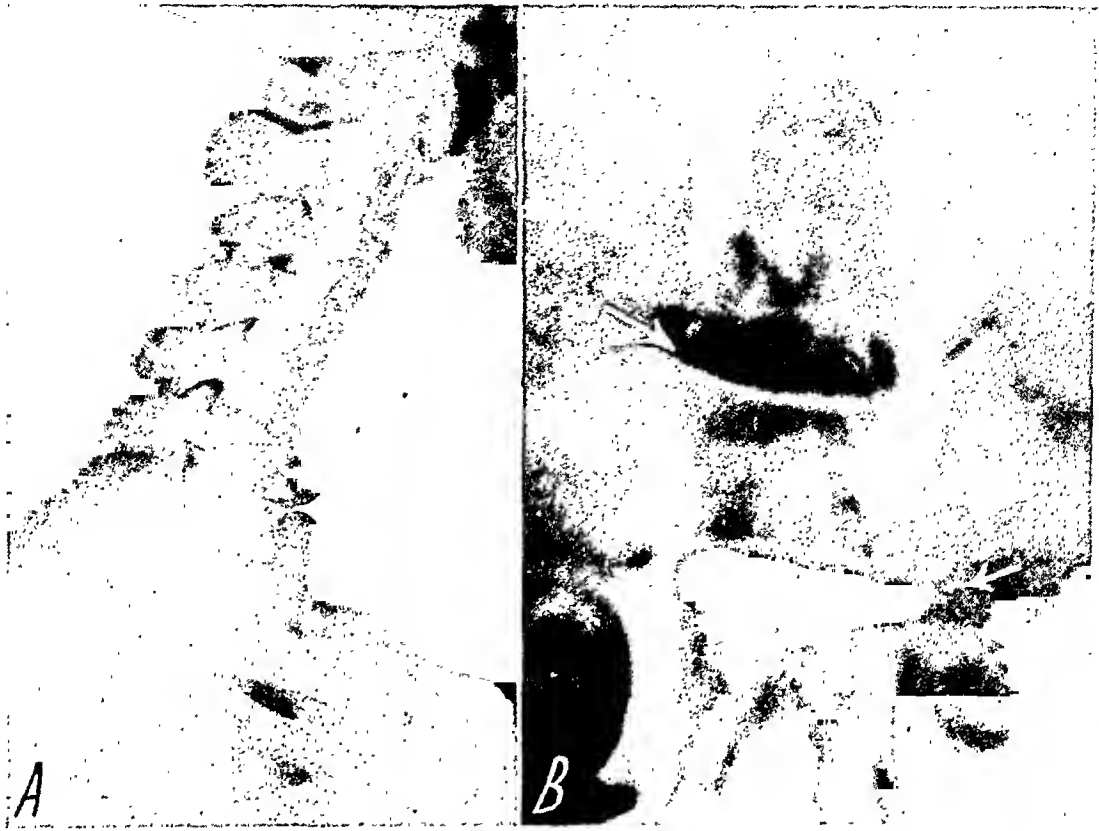


FIG. 7. Case VII. (A) reversal of normal curve; localized arthrosis of joint space between C-6 and C-7, evidenced by narrowing and anterior lipping. (B) obliteration of nerve root at C-6 on left and C-5 on right.

the operation it was noted that pressure on the disc reproduced the patient's precordial pain after the root had been injected with 2 per cent novocain. Immediately after operation the patient stated that all his symptoms had disappeared.

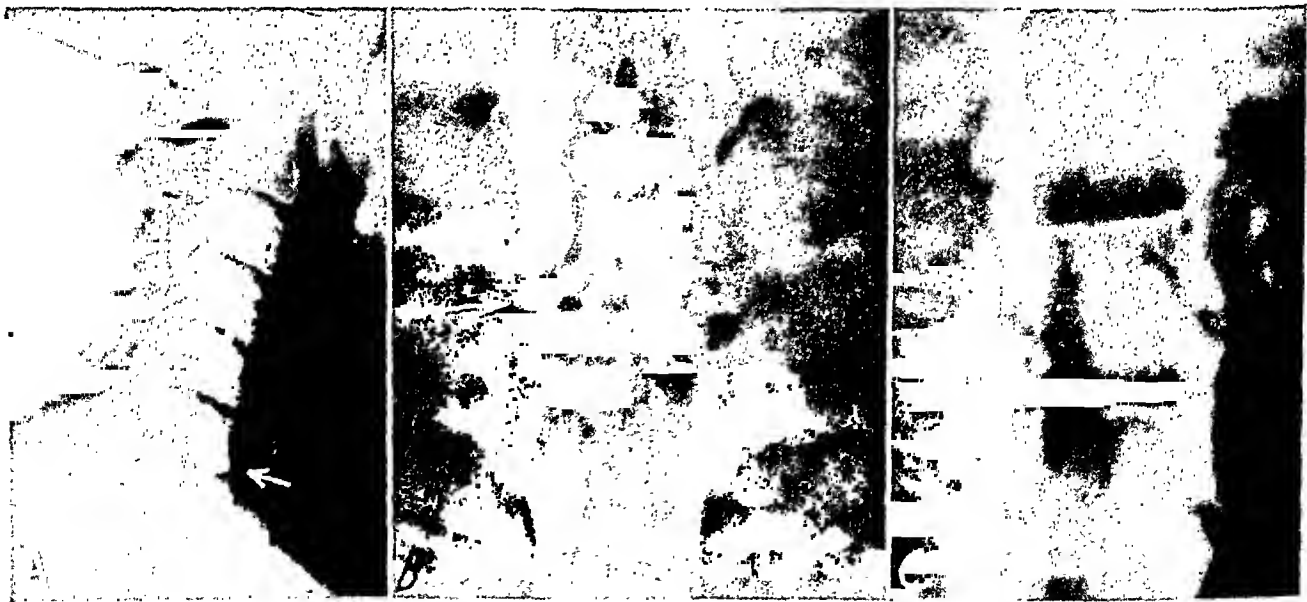


FIG. 8. Case VIII. (A) reversal of normal curve. Narrowing of joint space between C-6 and C-7 (B) large poorly circumscribed pressure defect with obliteration of inferior border of cuff of right nerve root at level of C-6. Pressure also present on spinal portion of subjacent nerve. (C) distortion of nerve root, narrowing of subarachnoid space, C-6, right. Defect in lamina from previous operative procedure. This was interpreted as either a recurrence or the result of scarring from the previous laminectomy.

CASE VIII. An officer, aged thirty-two, in 1938 had neck pain with radiation into the shoulder and right arm, of two days' duration. During the next five years he had five moderately severe attacks, lasting twenty-four to forty-eight hours, with residual soreness. On December 5, 1943, a severe attack took place overseas with pain which radiated into the outer arm, forearm and into index and middle fingers. The fingers of the right hand became numb. At an overseas hospital traction on the neck gave some relief,

of pain and slight residual numbness in the index finger. The patient returned to duty.

In March, 1945, the patient was overseas and while lifting a tub of water had a recurrence of his old pain with the same radiation, but in this attack the numbness and tingling were in the fourth and fifth fingers. Three days preceding the onset of this pain the patient had been blown out of a jeep by a land mine landing on his head. Conservative treatment in the form of traction and physical therapy gave no relief.

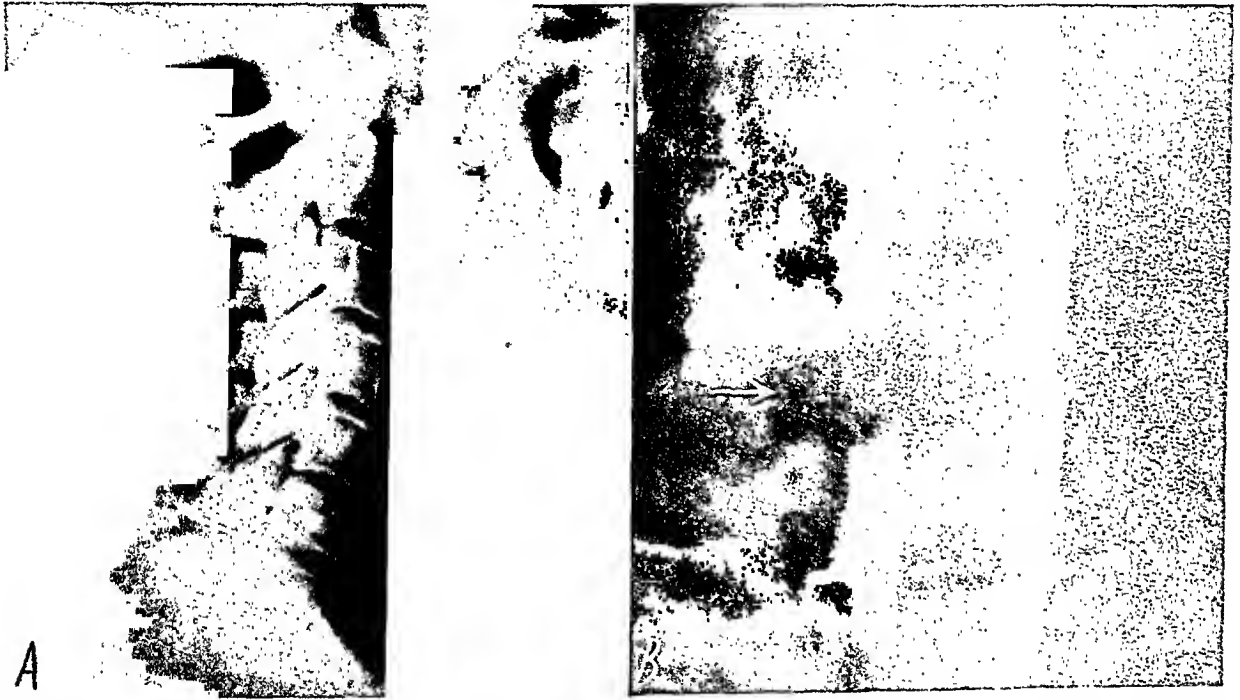


FIG. 9. Case IX. (A) segmental loss of curvature of lower spine with narrowing of joint space between C-6 and C-7. Posterior spurring also present at this level. (B) unilateral triangular defect at level of C-6 on right. Obliteration of nerve root cuff and displacement of spinal portion of root.

although narcotics were also used. Twisting neck to same side markedly aggravated pain as did coughing and sneezing. Past history reveals that patient was thrown from a horse in 1929 and suffered from a stiff neck as a result. On physical examination there was marked limitation of neck movement and marked tenderness over the scalenus anticus muscle at the level of the sixth transverse process. Rotation of the neck to the right reproduced pain. Right biceps jerk was reduced and hypesthesia in index and middle fingers was present. For roentgen findings, see Figure 8, A and B. A subtotal laminectomy with removal of a large herniated nucleus pulposus was done at the level of C-6 on the right. As a result there was a complete relief

He was returned to O'Reilly General Hospital and myelography again performed (see Fig. 8C). The old wound was reopened at the level of C-6 on the right and several loose pieces of herniated nucleus pulposus were removed from the same level as at the previous operation. This second operation completely relieved this pain and numbness.

CASE IX. A soldier, aged forty-two, developed neckache and right shoulder numbness in September, 1943. About one month later pain appeared on the outer aspect of right arm, forearm and thumb. He was hospitalized from duty on April, 1944. In May, 1944, he developed fibrillary twitches in triceps and biceps; atrophy

of upper extremity muscles was also noted at this time. Numbness in the right index finger, which was also present, persisted for six months. He was transferred to this hospital with a diagnosis of scalenus anticus syndrome. On physical examination pressure over the upper brachial plexus and rotation of the neck with pressure on the head reproduced pain. There was intermittent twitching in biceps and triceps muscles. The triceps and biceps jerks were questionably

border of the shoulder blade and radiated down the outer side of the right forearm into the index and middle fingers. He noted also a "hot spot" in the palm just proximal to the index finger. He could reproduce and exacerbate the pain by turning his head to the right and relieve it by turning his head to the left. Coughing and sneezing did not aggravate the pain. On physical examination compression and rotation of the neck to the right reproduced pain. There



FIG. 10. Case x. (A) straightening of the normal curve and calcification in anterior ligament in joint space between C-6 and C-7. (B) small triangular defect obliterating inferior cuff of root sleeve at C-6 on right. Superior cuff displaced cephalad.

reduced but the pectoral jerk was definitely reduced. Subjectively the patient noted the right upper extremity to be cold especially in hot weather when doing heavy work. Roentgen findings are shown in Figure 9, A and B. A subtotal laminectomy, with removal of the herniated nucleus pulposus between C-6 and C-7, was done. There occurred a complete relief of all symptoms.

CASE X. An officer, aged forty-nine, had a stiff neck for one week in July, 1944. Heat and massage gave no relief. Three days after stiffness cleared up he developed a pulling sensation in his right neck which extended down inner

was marked tenderness over the upper right brachial plexus. The right biceps and triceps reflexes were reduced. Hypesthesia was present in the entire index finger and along the palmar surface of the middle finger, but less marked. No vascular changes were noted. Roentgen findings are shown in Figure 10, A and B. A subtotal laminectomy, with removal of the herniated nucleus pulposus between C-6 and C-7, was done. The pain immediately disappeared but some residual hypesthesia in the index finger persisted.

CASE XI. A soldier, aged thirty-five, landed on his right shoulder in a ditch as a result of a

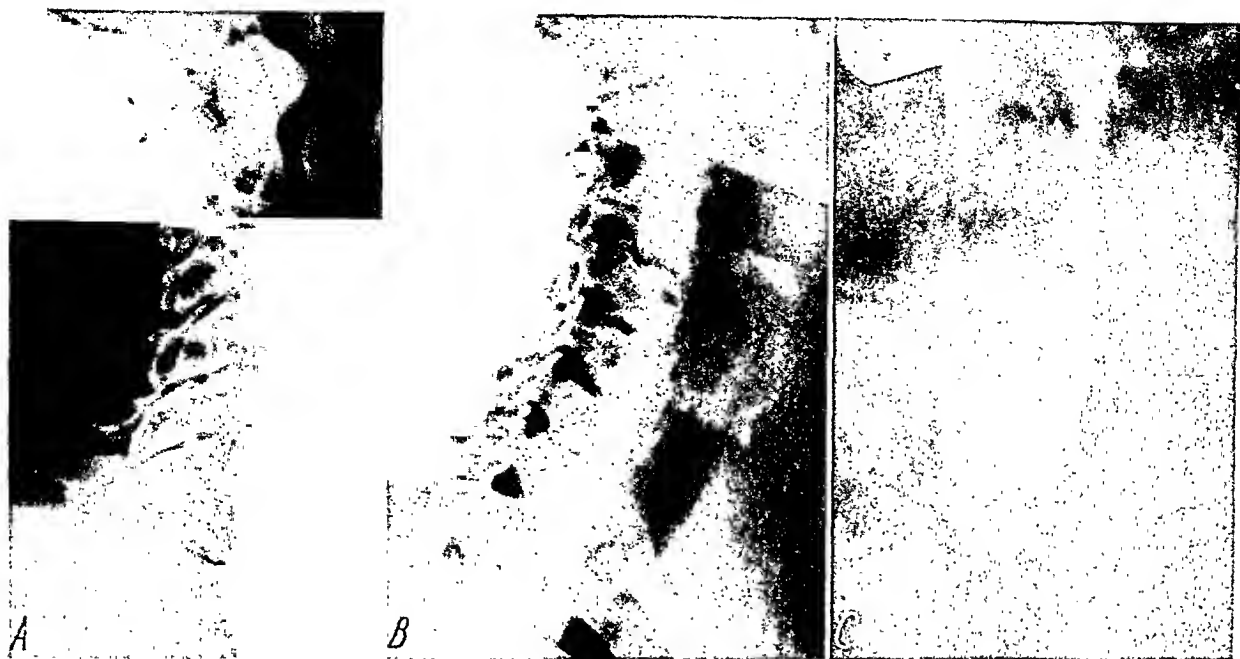


FIG. 11. Case XI. (A) localized arthrosis at level of C-6. (B) encroachment of foramen. C-6, right. (C) large "gap" defect obliterating nerve root at level of C-6 on right.

shell explosion on June 25, 1944, in France. He developed stiffness in his neck and severe headaches and pain radiating into the right eye. This was followed by some weakness of his right

arm, forearm, hand and shoulder during the next few months. In cold weather the right hand became purple. He was transferred from another Army General Hospital with a diag-



FIG. 12. Case XII. (A) normal curve. (B) large irregular "gap" defect almost obliterating nerve root at level of C-6 on right and extending to midline.

nosis of paralysis of the right brachial nerve. On physical examination the patient was unable to flex the distal interphalangeal joint of the right finger of the right hand. There was atrophy of the small muscles of this same hand, including the hypothenar and thenar eminence and particularly in the anatomical snuff box. There was numbness of the fingers and thumb of the right hand and an inability to adduct the little finger. Roentgen findings are shown in Figure 11, *A* and *B*. A subtotal laminectomy was done with removal of a large herniated disc. No improvement resulted.

CASE XII. An officer, aged forty, on December 1943, slipped on landing net, fell 3 or 4 feet and then caught net with right hand and swung on it. He felt as if he had torn something at the base of his neck. This was followed by pain in the neck, radiating to the shoulder, lateral aspect of arm, and numbness in the fourth and fifth fingers. The pain was fairly severe but he continued on duty until January 8, 1944. This was markedly aggravated by a long train trip. Treatment in a general hospital for five months with traction, a hard bed and physical therapy gave some relief. He went to duty but in October, 1944, he had a recurrence of stiff neck with pain radiating into the upper shoulder and ring and little fingers. This could be relieved by turning the neck in a certain position and increased by rotating the head and neck to the right. He was transferred to the O'Reilly General Hospital with a diagnosis of brachial plexus neuritis. On physical examination there was limitation of rotation of neck, hypesthesia in fourth and fifth fingers and decrease in the right triceps jerk. Rotation of the head and neck to the right, with compression on head, reproduced the patient's pain. There was marked tenderness over the scalenus anticus at the level of the sixth transverse process. Roentgen findings are shown in Figure 12, *A* and *B*. Patient was treated conservatively without any change.

SUMMARY

1. Rupture of the nucleus pulposus in the cervical region is relatively common.
2. In many cases the diagnosis can be made solely on the basis of the clinical findings.

3. Plain lateral and oblique roentgenograms of the cervical spine often provide helpful confirmatory information.

4. Positive cervical myelographic findings have proved highly accurate in this small series of operated cases.

5. The significance of negative cervical myelographic findings has not yet been completely determined although the evidence in this series suggests that a negative finding is of much more value than a negative finding in the lumbar region.

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REFERENCES

1. SEMMES, R. E., and MURPHEY, F. Syndrome of unilateral rupture of sixth cervical intervertebral disc, with compression of seventh cervical nerve root; report of 4 cases with symptoms simulating coronary disease. *J. Am. M. Ass.*, 1943, 121, 1209-1214.
2. SPURLING, R. G., and SCOVILLE, W. B. Lateral rupture of the cervical intervertebral discs; common causes of shoulder and arm pain. *Surg., Gynec. & Obst.*, 1944, 78, 350-358.
3. MICHELSEN, J. J., and MIXTER, W. J. Pain and disability of shoulder and arm due to herniation of the nucleus pulposus of cervical intervertebral disks. *New England J. Med.*, 1944, 231, 279-287.
4. EPSTEIN, B. S., and DAVIDOFF, L. M. Iodized oil myelography of the cervical spine. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 52, 253-260.
5. BROWDER, J., and WATSON, R. Lesions of the cervical intervertebral disc: clinico-pathologic study of 22 cases. *New York State J. Med.*, 1945, 45, 730-737.
6. KEYES, D. C., and COMPERE, E. L. Normal and pathological physiology of nucleus pulposus of intervertebral disc; anatomical, clinical, and experimental study. *J. Bone & Joint Surg.*, 1932, 14, 897-938.
7. OPPENHEIMER, A. Pathology, clinical manifestations and treatment of lesions of the intervertebral disks. *New England J. Med.*, 1944, 230, 95-105.
8. HADLEY, L. A. Roentgenographic studies of the cervical spine. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 52, 173-185.

THE PHANTOM NUCLEUS PULPOSUS

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THE nucleus pulposus has received intensive study since the stimulating work of Schmorl¹⁶ who directed particular attention to the subject of protrusions or herniations. Various infectious and degenerative diseases in connection with these protrusions have been described in the nuclei and in the surrounding tissues, among which might be mentioned nuclear expansion or ballooning, atrophy, calcification, infectious and malignant invasion. Another condition, only lately recognized,^{10,11} is one in which there is a loss of the nucleus pulposus without tissue replacement leading to an empty space or "vacuum."

CASE REPORTS

CASE 1. A white female, aged fifty-six, slipped on a staircase eighteen years before and landed on her sacrum. Pain and tenderness occurred

bed for the succeeding two months. The condition then improved and the symptoms disappeared after five months. No evidence of fracture or dislocation was revealed by the original roentgen examinations and there never has been radiation of pain nor any positive associated neurological findings. Periodically since this episode, there have been recurring attacks of low back pain treated by every conceivable method devised by practitioners of recognized and unrecognized schools of therapy. At present there are no positive physical findings except slight limitation of motion of the lumbosacral articulation. The roentgen examination reveals the presence of an ankylosing hypertrophic osteoarthritis of the lumbosacral articulation with a phantom nucleus pulposus. Examination of the patient in the erect position bearing weight on the lumbosacral spine reveals no change in the roentgen findings, nor does examination during flexion or extension of this



FIG. 1. Case 1. Phantom nucleus pulposus of lumbosacral articulation, anteroposterior view—25° cephalic angulation of central ray.



FIG. 2. Case 1. Phantom nucleus pulposus of lumbosacral articulation, lateral view.

immediately in the lumbosacral area, sufficiently intense and persistent to confine her to

portion of the spine make any difference. The phantom nucleus has been found repeatedly at



FIG. 3. Case II. Phantom nucleus pulposus of lumbosacral articulation. Anteroposterior view, 30° cephalic angulation of central ray.

each examination during the past two years (Fig. 1 and 2).

CASE II. A female, aged thirty-eight, fell out of a doorway of an automobile as it was going around a curve. She landed on her back and sustained several bruises, but no other injuries became apparent immediately. On the following day, she complained of a sharp low backache and this became progressively worse necessitating bed rest for two weeks. This condition gradually subsided during the next five weeks.

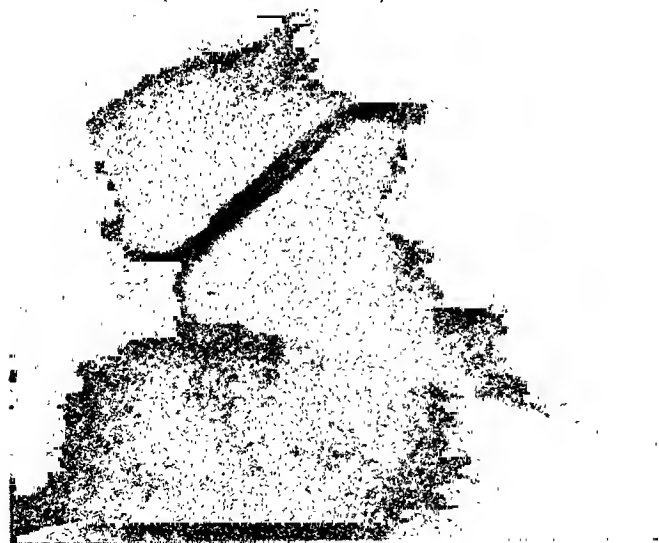


FIG. 4. Case II. Lateral view.

Since this initial episode, which occurred nine years ago, attacks of slightly incapacitating low back pain have recurred only three or four times, lasting never more than two to four weeks. The most recent roentgen examination was the first to reveal anything abnormal in the lumbosacral spine when a phantom nucleus pulposus was seen in the region of the lumbosacral articulation in association with minimal subarticular osteosclerosis of the first sacral segment. Only slight narrowing of the intervertebral space was present. The erect position of the patient with the spine in anteroposterior or lateral flexion or extension did not alter these roentgen findings (Fig. 3 and 4).

CASE III.* A male, aged fifty-eight, was felled by three prisoners whom he was guarding during the last war (1918) and thrown to the ground, kicked and trampled upon. He lost consciousness for almost twenty-four hours and then he found himself in a hospital with a sharp low backache which kept him confined to bed for 11 weeks. No evidence of fracture or dislocation was found and with bed rest and physical therapy, he gradually improved, being discharged back to active duty fourteen weeks after the date of injury. Never since then has he ever had any backaches that necessitated treatment; at least, so far as he could recall. During the course of a recent gastrointestinal examination, there was found incidentally, a hypertrophic osteoarthritis of the lower lumbar spine, characterized by minimal lipping of the articular margins of the bodies of the fourth and fifth lumbar vertebrae, subarticular osteosclerosis and phantom nuclei pulposi in this area. These vacuum spaces were best seen during extension of the lumbar spine (Fig. 5, 6 and 7).

DISCUSSION

In the 3 cases here reported, there was a history of a severe injury causing intense low backache incapacitating the patient for several weeks. In no instance was there evidence of fracture or dislocation of the vertebrae. Recurring intermittent backaches were experienced by 2 patients while the third apparently never was troubled again after the initial injury. Except for the unusual roentgen findings, none of the examinations revealed anything abnormal

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except slight limited motion of the lumbosacral spine in 2 of the 3 patients.

In no instance was there neurological evidence of herniation of the nucleus pulposus, yet the history of injury and the localization of the spondylitis to the area of injury leads one to the inference that trauma had some connection with the initiation of the pathologic process. Neither rupture of the longitudinal spinal liga-



FIG. 5. Case III. Phantom nuclei pulposi between fourth and fifth lumbar and first sacral segments.

ments, loosening of the attachments of the annulus fibrosus, damage to the cartilage plates nor the reparative fibrosis in these soft tissues can be visualized in a roentgenogram, but the marked subchondral osteosclerosis, which was present in each case, would point strongly to injury and inflammatory reaction in and around the cartilage plates. It is conceivable that loss of nuclear substance took place through defects in these cartilage plates, but no evidence of herniation actually was visible in the vertebral bodies and no patient had symptoms of posterior protrusion of the nucleus pulposus.

The annulus fibrosus and the nucleus pulposus are separate structures even



FIG. 6. CASE III. Lateral view.

though in adult life they may seem to blend together. The fibers composing the annulus are arranged complexly, one major group being connected with the hyaline cartilage covering the articular surfaces of the vertebral bony, another group in-



FIG. 7. Case III. Lateral view, with extension of spine, accentuating "vacuum phenomena" seen in Figure 6.

serting into the longitudinal ligaments and a third group sinking into the bony edges of the vertebral bodies like Sharpey's fibers. The overgrowth of bony tissue along the rim of the vertebral bodies, often referred to as osseous lipping and seen in spondylitis following injury, occurs in those portions of the body where these fibers of the annulus insert. It would be difficult to understand how extrusion of some nuclear material could be prevented in such cases, especially since the nucleus pulposus is always under tension. Could this mechanism, explaining the loss of nuclear substance in traumatic spondylitis, also explain the vacuum phenomena found by Knutsson¹⁰ in cases of osteochondrosis juvenilis, a condition not always associated with trauma?

The *Randleiste* of Schmorl or the epiphyseal peripheral bony rings which develop during adolescence, first reveal small foci of calcium between six and eight years of age in girls and seven and nine years of age in boys. These foci ossify and fuse to form marginal bony rings surrounding the superior and inferior brims of each vertebral body with which they begin to fuse between fourteen and fifteen years of age. This fusion becomes complete at twenty-one to twenty-five years, being slowest in the lumbar area. Schmorl showed how fibers of the annulus fibrosus are firmly anchored in these epiphyseal rings which are the structures apparently most involved in adolescent osteochondrosis. The disintegration and aseptic necrosis of these *Randleiste* disturbs the integrity of the annulus fibrosus and the cartilage plates so that dissection, seepage, or absorption of some nuclear substance might occur under these circumstances. If the adult nucleus pulposus cannot seep easily through rents in the annulus because of its fibrogelatinous texture, at least in younger subjects when its water content is relatively high,¹⁴ leaks in the annulus or in the cartilage plates easily may allow seepage or absorption to take place. This theory is not difficult to accept since herniation of the nucleus

pulposus has been reported following simple lumbar puncture.^{6,13} Since the nucleus pulposus is derived from endoderm, being in part a remnant of the notochord, any loss of its substance is not renewable like synovial fluid in other joints. In *osteochondrosis juvenilis*, once there has been a loss of some nuclear material, the emptied space can be enlarged by extension of the spine, effecting sufficient reduction in atmospheric pressure to result in the vacuum phenomena described by Knutsson. In *hypertrophic osteoarthritis*, after the loss of nuclear substance, the fibrohyaline annulus fibrosus prevents actual contact of the opposing articular surfaces because of its interposed position between the vertebral bodies. The space formerly occupied by the healthy nucleus thus is *not* encroached upon and this empty space remains a "vacuum" which can be roentgenographed. This space can be demonstrated more easily by traction or extension of the spine, but not so easily as in osteochondrosis because of the greater periarticular ankylosis.

A congenital central cavity in the nucleus pulposus has been described and this has been compared to a rudimentary joint cavity. Saunders and Inman¹⁵ thought that these central cavities resulted from "desiccation" of the nucleus pulposus, but Coventry, Ghormley and Kernohan² ascribed their appearance to the exigencies of sectioning and staining for microscopic study. The possibility of a congenital cavity in the nucleus pulposus is not to be dismissed entirely in appraising the appearance of the phantom nucleus pulposus.

The healthy nucleus pulposus acts as a hydrodynamic ball bearing. It is under tension which is greater in youth than in old age. If nuclear material is lost, either by extrusion, dissection, absorption or atrophy following damage by mechanical or infectious forces, the disc cannot transmit the spinal column stresses and strains without increasing the wear and tear on apophyseal joints and perispinal ligaments. The pain and rigidity of adolescent osteo-

chondritis and ankylosing spondylitis apparently are due in some measure to these factors. While Magnusson¹¹ may have regarded the "vacuum phenomena" of the nucleus pulposus as mere curiosities, it is true that the intervertebral joint suffers an important physiologic handicap in the loss of the nucleus pulposus.

In posterior protrusions of the nucleus pulposus which produce symptoms, narrowing of the interarticular spaces between the vertebral bodies is seen rarely. The evacuated nuclear space is filled possibly by the swollen and redundant fibers of the annulus fibrosus. In only 2 cases of 88 pathologic specimens did Coventry, Ghormley and Kerohan² find gross evidence of thinning of the intervertebral disc in cases of posterior nuclear protrusions. They usually found some nuclear residues, often necrotic and pigmented in character.

The intact anatomical joint space was roentgenographed more than thirty years ago by Fick⁵ and his co-workers, curiously enough in the Röntgen Institute in Würzburg. By using traction on the joints, they were able to create an intracapsular vacuum which revealed the intracapsular space. Dale³ in 1930 reported on the presence of a radiolucent line in the symphysis pubis of gravid women late in pregnancy; later, Grashey,⁸ von Pannewitz,¹² Hippe and Hähle,⁹ and Widmann and Stecher¹⁷ reported on spontaneous visualization of the interarticular joint space. Dittmar⁴ in 1932 demonstrated how the knee menisci could be roentgenographed by intentional traction or abduction of the knee and the application of this procedure in the study of internal derangement of the knee joint has been reported recently.⁷ Now it is generally recognized that almost any joint in the body can be demonstrated in the living by traction sufficient to create a vacuum in the capsule. Magnusson,¹¹ who studied the physical conditions which would produce evaporation of synovial fluid in a joint, pointed out that the intracapsular pressure would have to be reduced to one-twentieth of an at-

mosphere to produce a "vacuum phenomenon." Other factors in this mechanism of practical importance may be the flexibility of the periarticular soft structures and the amount of synovial fluid in relation to the size of the potential intracapsular space. In one instance, with a relatively large quantity of fluid, and with inelastic capsular-pericapsular structures, even vigorous mechanical traction may fail to achieve a sufficient reduction of intracapsular pressure to produce a discernible vacuum in the roentgenogram. In another instance, with a large capsular space, with a small amount of synovial fluid and with elastic pericapsular structures, mechanical traction may easily cause a visible roentgenographic vacuum. Vacuum phenomena in the healthy joint has received little study, but even less attention has been paid to this condition in the diseased joint.

Knutsson found vacuum phenomena in at least two different conditions: (1) in cases of disc degeneration (osteochoondrosis), and (2) in cases of spondylitis deformans. In osteochoondrosis, he described drying of the disc substance during the process of degeneration and since the annulus fibrosus remains intact, irregular air streaks corresponding to the cracks in the dried portion of the disc appear in the roentgenogram. The width of these cracks in the degenerated discs may sometimes be widened by extension of the spine when the increased vacuum so produced becomes more prominent. Knutsson claims that these vacuum streaks in the region of the degenerated disc may be the only positive roentgen sign of osteochoondrosis, appearing before or without the development of the other usual roentgen signs. In spondylitis deformans, cracking and partial detachment of the annulus fibrosus may occur, so that the vacuum phenomenon extends beyond the confines of the nucleus pulposus. This is the only point of differentiation Knutsson makes of the vacuum phenomena between osteochoondrosis and spondylitis deformans.

The roentgenologist has contributed

much to the diagnosis of nuclear protrusions and disease and now, perhaps, besides the use of intraspinal contrast media, he can add more by studying the vacuum phenomena in healthy and diseased joints.

SUMMARY

The phantom nucleus pulposus results in the roentgenographic appearance of an empty space or vacuum in that portion of the intervertebral disc normally occupied by this structure. This phenomenon is described in three cases of traumatic spondylitis in the lower lumbar spine and in the lumbosacral articulation. The mechanism leading to this condition in relation to other abnormal changes of the nucleus pulposus is discussed. Use of the roentgenographic "vacuum technique" to demonstrate the healthy and diseased joint and its diagnostic possibilities for the further study of joint diseases is reviewed.

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REFERENCES

1. BRADFORD, F. K., and SPURLING, R. G. The Intervertebral Disc with Special Reference to Rupture of the Annulus Fibrosus with Herniation of the Nucleus Pulposus. Charles C Thomas, Springfield, Illinois, 1941.
2. COVENTRY, M. B., GHORMLEY, R. K., and KERNOHAN, J. W. Intervertebral disc; its microscopic anatomy and pathology; anatomy, development, and physiology. *J. Bone & Joint Surg.*, 1945, 27, 105-112; 233-248; 460-474.
3. DALE, T. New technic for roentgen examination of symphysis pubis in women. *Norsk mag. f. laegevidensk.*, 1930, 91, 782-785.
4. DITTMAR, O. Der Kniegelenks-Meniskus im Röntgenbilde. *Röntgenpraxis*, 1932, 4, 442-445.
5. FICK, R. Handbuch der Anatomie und Mechanik der Gelenke II. G. Fischer, Jena, 1910.
6. GELIMAN, M. Injury to intervertebral discs during spinal puncture. *J. Bone & Joint Surg.*, 1940, 22, 980-985.
7. GERSHON-COHEN, J. Internal derangements of the knee joint; diagnostic scope of soft tissue roentgen examinations and vacuum technique demonstration of the menisci. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 54, 338-347.
8. GRASHEY, R. Sichtbarer Schultergelenkspalte. *Röntgenpraxis*, 1933, 5, 700.
9. HIPPE, H., and HÄHLE, K. Zur Frage des wahren Gelenkspaltes. *Röntgenpraxis*, 1936, 8, 98.
10. KNUTSSON, F. Vacuum phenomenon in intervertebral discs. *Acta radiol.*, 1942, 23, 173-179.
11. MAGNUSON, W., Ueber die Bedingungen des Hervortretens der wirklichen Gelenkspalte auf dem Röntgenbilde. *Acta radiol.*, 1937, 18, 733-741.
12. VON PANNEWITZ, G. Sichtbarwerden des wahren Gelenkspaltes bei Arthritis deformans. *Röntgenpraxis*, 1933, 5, 809-810.
13. PEASE, C. N. Injuries to the vertebrae and intervertebral disks following lumbar puncture. *Am. J. Dis. Child.*, 1935, 49, 849-860.
14. PÜSCHEL, JOHANNA. Der Wassergehalt normaler und degenerierter Zwischenwirbelscheiben. *Beitr. z. path. Anat. u. z. allg. Path.*, 1930, 84, 123-130.
15. SAUNDERS, J. B. DE C. M., and INMAN, V. T. Pathology of intervertebral disk. *Arch. Surg.*, 1940, 40, 389-416.
16. SCHMORL, G. Die Gesunde und kranke Wirbelsäule im Röntgenbild: Pathologisch-anatomische Untersuchungen. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, Ergänzungsband 43. G. Thieme, Leipzig, 1932.
17. WIDMANN, B. P., and STECHER, W. R. Roentgenographic demonstration of the true articular space. *Radiology*, 1936, 27, 541-544.



ROENTGENOGRAPHIC PREPARATIONS FROM GROSS ANATOMIC SECTIONS¹

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IN THE study and teaching of roentgenographic anatomy a knowledge of the location of the various structures within the human body and their relation to surrounding organs, muscles and bones is of fundamental importance. The proper "positioning" of the patient during the roentgenographic examination and the manner of surgical approach are dependent upon such information. The need for more precise information of this kind led us to devise the method and the apparatus described herein. Regular methods were first employed, but were found to be unsatisfactory, because of the difficulty encountered in maintaining normal relationships among sectioned structures, and because of the impracticability of using gross sections in laboratory teaching or for extramural lectures.

Gross sections, though limiting the observer to a portion of each organ or system, reveal most graphically the location of all anatomic parts, and their relation to all important topographical neighbors. Ordinary sections, however, are unwieldy; they darken upon exposure to the air; their elements are easily dislodged or distorted; they require excessive space for storage and they are difficult to transport; they give no hint of histologic detail, and in them the course of vessels and nerves, of muscle fascicles, or of smaller hollow viscera can be

followed only by destructive probing. Despite these common handicaps, little improvement in the preparation or exhibition of sections has been made since they first came into general use. Traditionally, the cadaver was fixed in formalin, frozen, and then cut by hand or by band saw, in rather thick sections; the sections were then left free and unguarded for examination, or mounted in alcohol (in brass trays, covered by glass plates sealed with wax).²

It was our ambition to cut sections thin and uniform, and to prepare convenient, life-sized, pictorial records of these originals. By these means, relationships could be shown at more frequent levels; sections would be uniformly thick throughout their breadth; they could, by photography, be converted into a form convenient for demonstration, storage and transportation; by roentgenography, the internal relations could be demonstrated, and some of the macroscopic structure, intermediate between the gross and the microscopic, could be brought out to view.

The articles of equipment employed were as follows: Vaughan high-speed band saw; special table with tracked top and demountable support (Fig. 1); imbedding

¹ Contribution No. 437 from the Department of Anatomy, Northwestern University Medical School; a study carried out in association with the General Electric X-Ray Corporation. All special exhibition cases, etc., were provided by General Electric, from specifications prepared by H. O. Mahoney and R. F. Dent.

Roentgenograms prepared in the manner herein described were exhibited first at the Kansas City (1936) meeting of the American Medical Association (awarded Honorable Mention); by invitation at the meetings of Illinois State Medical Society, Springfield, 1936 (Certificate of Merit), Fifth International Congress of Radiology, Chicago, 1937, and at the San Francisco (1938) meeting of the American Medical Association. A set of roentgenograms is on permanent exhibition at the Army Medical Museum, Smithsonian Institute, Washington, D. C.

² Cross-section containers, designed by Prof. W. W. Looney of the Baylor University College of Medicine, have been purchasable for some time. They consist of a circular aluminum tray, the front of which is glass set airtight in rubber. Sections are mounted in plaster of Paris, the compartment filled with preservative through an orifice which is then closed by a screw plug. Each can be suspended from the wall by a hook; they can be removed for study at table. They are available in sizes large enough to accommodate all transverse sections, except those taken through the shoulder region. So far as we know, larger containers of similar type (for sagittal and coronal sections) have not been successful; the glass covers are prone to crack, and the assemblage is unwieldy.

Even if such preparations were, from the mechanical standpoint, wholly satisfactory for local display within a medical school, they would not be adaptable to extramural teaching, since, in many states, such material could be transported only by licensed embalmers. And no matter how skillfully they may be prepared, the actual section is not as analytical as a roentgenogram prepared therefrom.

box; refrigerating (and dehydrating) unit; General Electric X-ray machine; large-field camera and enlarging apparatus; display cases for roentgenograms (Fig. 2 to 4).

It was found, through repeated trials, that a section three-fourths of an inch thick is most satisfactory; a slice of such thickness gave minimal superimposition of tissue, while offering sufficient bulk to hold the various structures in place without artificial aids. In order to produce a uniform

danger of disturbing the loosened structures (intestine, brain, etc.). The position of the hinged shelf in relation to the saw blade determines the thickness of the cut. A newly set blade should be used for each cadaver. The rate of speed at which the part should be cut varies with the structures through which the saw must pass; to force the cutting is to produce uneven slices. Experience has shown that moderate travel is best for all parts except the teeth

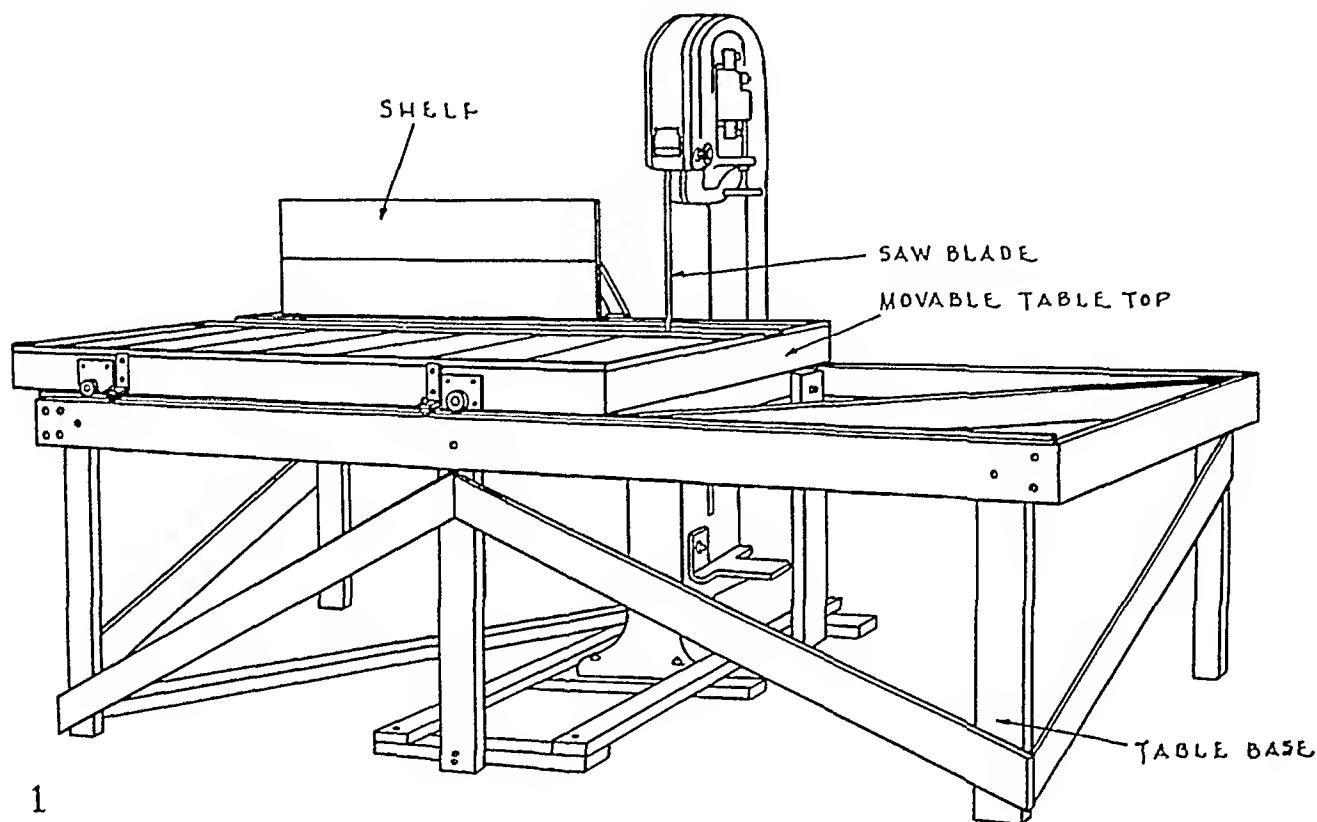


FIG. 1. Band saw with table carrying tracked top.

slice of optimum thickness, in the various planes—transverse, sagittal and coronal—a movable platform is required to feed the anatomical piece to the stationary saw (Fig. 1). The platform travels past the saw blade on rollers running on a metal track, the latter being mounted on a table. On the side of the table nearest the saw a ledge is mounted, against which the ice or paraffin block, with imbedded specimen, rests during cutting. The shelf is attached to the table top by hinges which allow it to be brought to a horizontal position, thus permitting the removal of the section from the table to a wire-mesh framed screen without

and the petrous portion of the temporal bone; to compensate for their resistance, the switch should be set to operate the saw at high speed, or the speed of travel of the table reduced.

A demountable box is used to hold the imbedded cadaver. Care should be exercised to construct it with sides and ends meeting the floor at right angles. Into this the specimen is fitted in supine position. The specimen should be formalin injected (10 per cent solution); during the process the cadaver should be straight, every effort being made to avoid lateral flexion of the vertebral column and flexion of the ex-

trémities. After injection, the cadaver should be refrigerated for at least five weeks. In preparation for cutting, cotton is placed in the nostrils, ears, and mouth; all hair is shaved from the body, and the extremities are removed for separate sectioning. The upper extremities should be cut through the axilla in the parasagittal plane, and the lower extremities transversely cut just below the tuberosity of the ischium.

The part to be sectioned (trunk or extremity) is placed in the box with the long axis of the body in correspondence with that of the box. Melted paraffin is then poured over the part until it is completely covered. The box is then placed in the refrigerator for twenty-four hours to hasten the process of hardening. Long freezing results in too great dehydration, and usually causes paraffin to break away from the specimen in the process of cutting.³

As each section is cut it is washed to remove blood, intestinal contents and other residue; then it is transferred from the hinged shelf of the rolling platform to a screen or to a sheet of heavy strawboard for temporary storage preparatory to being used in any one of several ways hereinafter described.

If the sections are to be employed for class instruction in the regular course in gross anatomy, or for more specialized examination and demonstration in topographical anatomy, they may be kept in humid metal boxes⁴ or mounted in fluid.⁵ Even if they are to be employed in this conventional way, the superiority of sections prepared in the manner just described would warrant building of the special table

and imbedding unit. However, the teaching possibilities of such sections can be exhausted only by using them, also, for photography and roentgenography. This matter calls for further discussion.

For class instruction sections are discouragingly awkward: as customarily prepared they cannot be demonstrated to large groups; they are generally unwieldy to store and awkward to transport. Only the anatomical features on their surfaces (or one surface, if mounted) are evident. Natural-sized photographs of the sections prove to be highly adaptable; they are easily transported, require surprisingly little space when stored, and can be demonstrated to large groups. Even more useful are roentgenograms prepared from the same gross sections; when accompanied, in lecture-demonstration, by the photographs referred to above, the value of the roentgenograms is further increased, since the internal morphology of the individual section is revealed to the observer.

In roentgenograms of sections, three-dimensional detail is recorded to an astonishing degree. Noteworthy among the macroscopic features clearly visualized are the following: ramifications, in the liver parenchyma, of hepatic and portal blood vessels; course, from origin to insertion, of fascicles of the coarser skeletal muscles (glutei, adductores, obturatores, sacrospinalis, recti abdominis, psoas, etc.); course of mesenteric arteries from aortic source to intestinal termination; lumbar nerves, from medullary origin through vertebral and intervertebral and intermuscular course; dural infoldings in relation to cerebral and cerebellar hemispheres; dural venous sinuses; carotid vessels; great vessels leaving and entering cardiac chambers; trabecular elements in long and in flat bones; internal supporting ligaments of the major joints of the extremities; pulmonary ramifications of blood vessels and bronchi; perineal contents in relation to fascial plates.

The preparation of photographs of the sections requires nothing novel in the way

³ The use of ice as an imbedding medium was tested, but was found to be unsatisfactory.

⁴ A metal box with tray-like false bottom is best. Dilute phenol solution (5 per cent), in rather small amount (and not reaching the tray), will suffice; it will not only keep the atmosphere humid, but will also serve to prevent molding of such small detached pieces of the section as may collect at the bottom of the container.

⁵ Very satisfactory "pans" for museum display of individual sections can be made of brass. The section is imbedded in plaster of Paris, a glass cover fitted snugly into the pan. Alcohol (70 per cent) is used as preservative. A minute opening is made in the glass to permit escape of excess fluid as the cover is fitted into place; the vent is then closed with wax. Wax may be used to seal the cover in place.

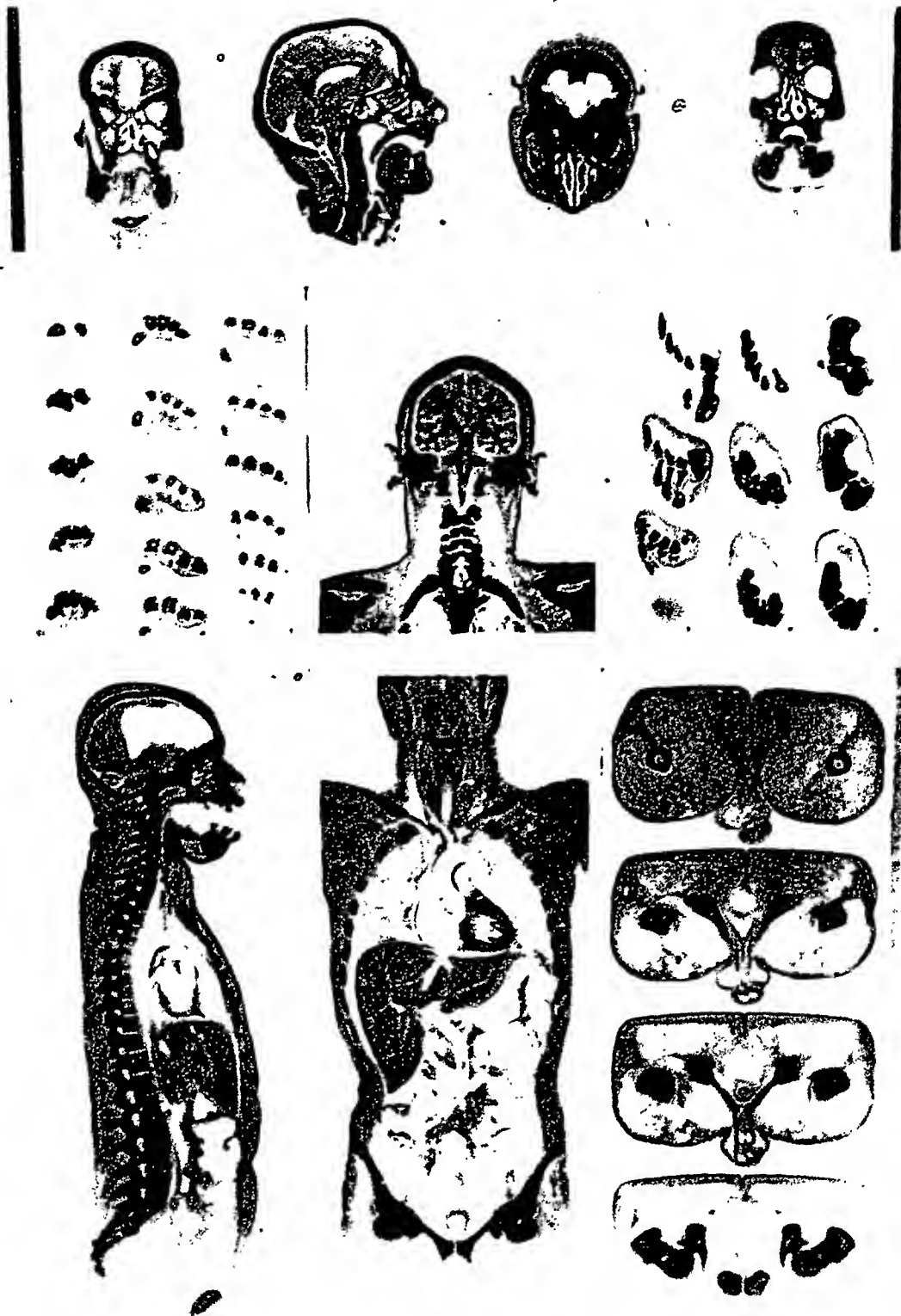


FIG. 2. Display case with roentgenograms.

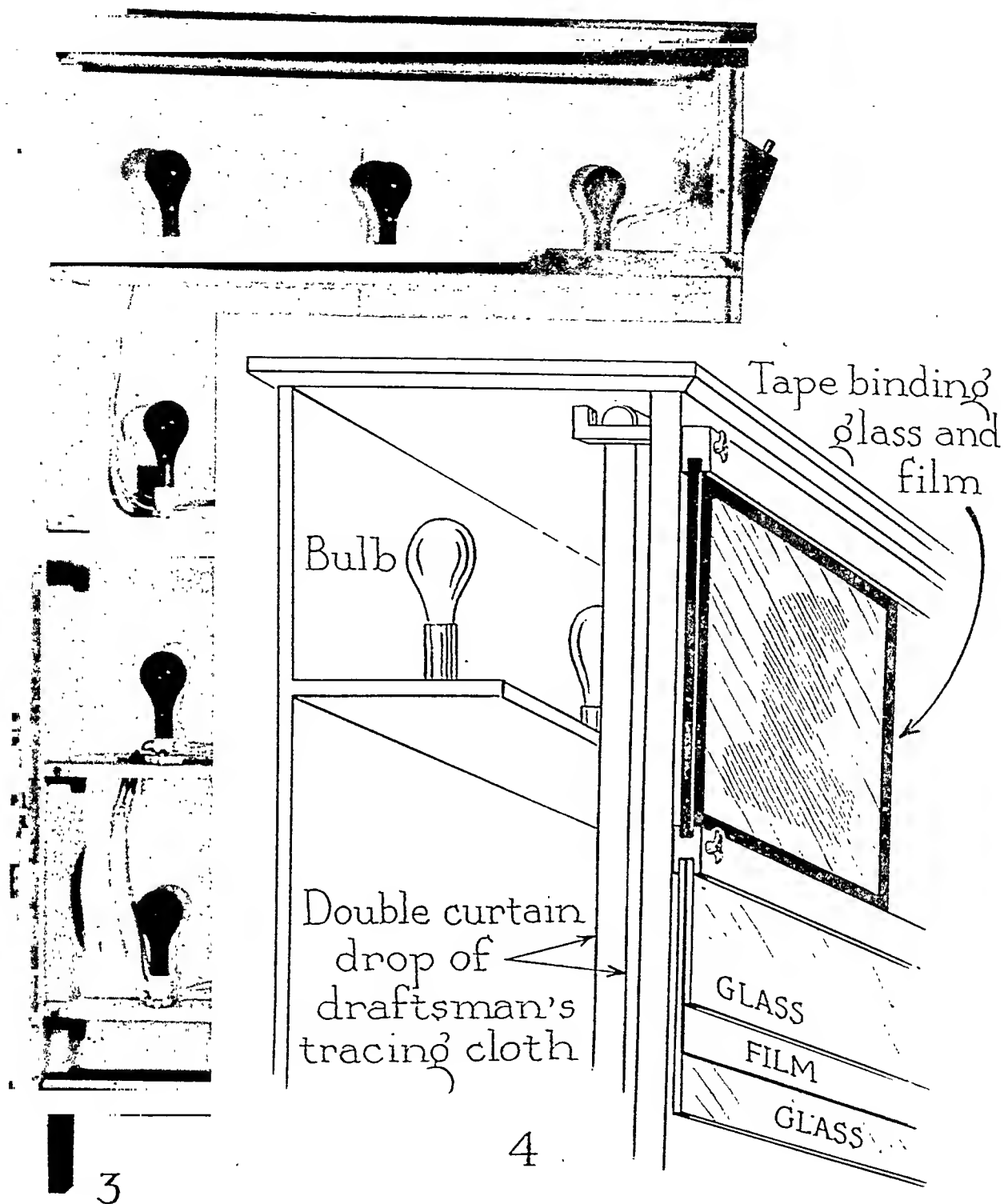


FIG. 3. Display case; curtain removed to show illuminating units.

FIG. 4. Display case; details of structure. Illustrating method of mounting films between plates of glass and of holding plates in grooved supports in front of translucent cloth.

of technique or equipment; however, new methods and apparatus are needed for the preparation of the roentgenograms and special exhibit cases are required for their advantageous display (Fig. 2 to 4).

In order to render the sections suitable for roentgenography, slow but considerable drying is essential. This is accomplished by storing them in the refrigerator for approximately a year, during which time they

should be examined periodically; optimum desiccation is that marked by separation of muscle fascicles, and retraction of the latter from the investing fascial layers. Usually this is a reliable indicator for all of the other tissues. However, in some instances parenchymatous organs hold fluid longer than do muscles, so that trial roentgenograms must be taken. When tissues are still soggy with contained embalming solution, the area affected appears blurred in the roentgenogram, and is completely wanting in details of macroscopic architecture. Storage on trays made of wide-meshed screen held by frames is desirable; in this way drying is uniform from both cut surfaces. When trays are piled in tiers, blocks should be placed between frames to prevent adjacent sections from touching each other.

In making the roentgenograms a mobile General Electric unit is used, the pictures taken on non-screen film.⁶ In our series a complete set of roentgenograms was prepared of each of three cadavers, sectioned in transverse, sagittal and coronal planes; for the transverse series an upper and a lower extremity were sectioned. Recognizing that much of the teaching value, for medical students, of such material depends upon its availability for continued reference as an auxiliary to dissection, special exhibit cases were prepared for display of the roentgenograms. These are essentially an enlarged form of roentgenogram viewing unit (Fig. 2). Each is a free-standing wooden case having the following dimensions: height $5\frac{1}{2}$ ft., width 4 ft., depth 1 ft.

⁶ The exposure factors were 25 kv. (peak), 5 ma., 72 inch distance and 20 to 60 seconds, depending upon the thickness of the sections and the degree of dehydration.

The case, open in front, is provided with twelve 150 watt lamps, arranged in three horizontal sets. In front the case is provided with wooden cross pieces, movable up and down, and provided with wing-bolts by which they can be fixed at selected horizontal level, to accommodate roentgenograms of different sizes (Fig. 3 and 4). For proper diffusion of the light, a curtain of draftsman's tracing cloth is hung in front of the bulbs. For classroom or museum display the roentgenograms are mounted between glass plates which are fastened together with Scotch tape (Fig. 4). Since the slotted supports are adjustable, the smaller transverse sections can be displayed adjacent to the larger coronal or sagittal sections whenever it is helpful to invite comparison between horizontal and vertical relations, or to employ one of these to supplement the other.

Roentgenograms, even when mounted in protecting glass, are not bulky; in a laboratory they can be stored conveniently. For use in more mobile form, for extramural lectures, they may be used unmounted—as roentgen films are regularly handled. Then the roentgenograms covering the three full series can be transported in a single box of the kind used in commercial shipping of original negatives.

Any one of the series of anatomically complex roentgenograms may be made much more serviceable for semipermanent or permanent display by placing next to each roentgenogram a labelled adumbration; the latter is prepared simply by tracing the structures on translucent paper and adding leaders and labels with india ink.



ABERRANT PANCREAS

By LIEUTENANT COLONEL ARTHUR J. PRESENT

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THE presence of aberrant pancreatic tissue in various portions of the abdomen and particularly in the wall of the gastrointestinal tract is not uncommon. It is of sufficient frequency to warrant its consideration in the differential diagnosis of so-called "filling defects" noted in the course of barium studies. Most of such nodules are small, cause no symptoms and have been found during post mortem examinations or incident to surgery. However, a sufficient number of cases have been reported in which the ectopic tissue caused or was associated with obstruction, intussusception or other abnormalities to warrant consideration of these masses as something more than anatomical curiosities. In addition to these mechanical complications, it is recognized that such tumors may be subject to pancreatitis, malignant change and to proliferation of islet tissue producing hyperinsulinism.

Examples of all of these conditions are to be found in the complete review of the reported cases of aberrant pancreas up to 1939 by Faust and Mudgett.¹ Mitchell and Angrist,² in 1943, added 11 cases of their own and collected 21 additional instances from the literature. Since that time Troll³ has reported 3 cases, Chapman and Mossman⁴ 1 case, and Brown, Flacks and Wasserman⁵ a single case. The latter case was seen roentgenographically in the duodenum. A single case of unusual interest was not included in previous reviews. Reported by Ballinger⁶ as the only known instance of aberrant pancreas in the liver, the patient had presented symptoms of hypoglycemia for six months prior to death. Postmortem examination revealed a carcinoma of the ectopic nodule, largely islet tissue, with no evidence of adenoma or primary carcinoma in the pancreas. A sum-

mary of the collected cases, with the 2 cases here reported included, is indicated in the following tabulation:

Stomach	110
Duodenum	117
Jejunum	68
Ileum	21
Small intestine (not located)	6
Diverticulum—stomach	3
Diverticulum—duodenum	7
Diverticulum—jejunum	1
Diverticulum—ileum	8
Meckel's diverticulum	2
Diverticulum of small intestine (not located)	2
Diverticulum (not located)	1
Umbilical fistula	1
Mesentery	3
Omentum	4
Liver	1
Splenic capsule	3
Spleen	1
Gallbladder	5
Cystic duct	1
Gastrocolic ligament	1
Transverse mesocolon	1
Location questionable	18
Total Cases:	410

It is apparent that the most frequent location of aberrant pancreas is, as might be expected, near the normal pancreatic bed. About one-fourth are reported in the stomach. Only in 1 or 2 instances have such tumors been visualized on roentgenograms.

Two cases, both in the antrum of the stomach, were studied roentgenologically at Hoff General Hospital, Santa Barbara, California.

CASE 1. The patient, a white male, aged thirty-three, was admitted on March 9, 1942. He complained of "stomach trouble" which had been present for two or three years and which was manifested by loss of weight, intermittent nausea, vomiting and hematemesis. There had been some epigastric pain, not persistent, with a variable relationship to eating. Milk gave re-



FIG. 1. Case 1. Intramural pancreatic nodule.

lief but none was obtained from alkaline powders. Tarry stools had been noted. Physical examination revealed evidence of weight loss, poor oral hygiene, chronic tonsillitis and tenderness in the mid-epigastrium and right upper quadrant. Laboratory studies were negative except that blood was found in all gastric specimens and in the stools. The sedimentation rate was 31 mm. per minute.

Roentgenographic studies of the gastrointestinal tract demonstrated no abnormalities of the esophagus. The proximal stomach was essentially normal. In the immediate prepyloric region a smooth, round, filling defect was persistently noted on the greater curvature (Fig. 1 and 2). This could not be erased by palpation but was movable and seemed small and intramural. Peristalsis did not pass through the area, but the mucosal pattern was seen to change. The duodenum was not unusual. A 5-10 per cent gastric retention was present at six hours.

Three gastroscopic studies were performed in an effort to visualize this deformity. The first two were noteworthy because, despite fair visualization, no abnormality was seen. The third revealed a suggestion of a mass interpreted as an intramural antral tumor.

At surgery a firm mass was found on the posterior and inferior aspect of the pylorus. Adherent to this mass was a cone of tissue which proved to be pancreas. The right half of the pancreatic bed was empty and the left contained what was felt to be pancreatic tissue lying obliquely and pointing up toward the stomach. The pylorus seemed to be obstructed by the mass and the cone of tissue could not be dissected away because of vascularity. A Finney

pyloroplasty was done. Convalescence was rapid and gastric symptoms disappeared. A postoperative roentgen examination showed the pyloric defect still to be present, but there was no retention in the stomach.

CASE II. The second patient was a white soldier, aged thirty-three, admitted to Hoff General Hospital on April 7, 1944. He complained of intermittent right upper quadrant pain of five years' duration, occasionally shifting to the mid-upper abdomen. It was dull, aching and accompanied by nausea. These symptoms usually followed constipation of two or three days' duration and were relieved by catharsis or enemata. Infrequent vomiting had occurred. In 1940 a gastrointestinal series and gastroscopy had been performed prior to entry on military service, and the patient had been told that a polyp had been found.

On physical examination a reducible right, incomplete, indirect inguinal hernia was the only positive finding. All laboratory studies were within normal limits. Roentgen studies of the gastrointestinal tract showed two large areas of diminished density in the barium shadow of the antrum (Fig. 3 and 4). One, the superior, appeared to be a fold of mucosa and could be displaced on palpation. The second, on the greater curvature, persisted despite manipulation and was well visualized as a polypoid lesion on spot roentgenograms. The entire area was flexible. Gastroscopecally a polyp 2 by 2



FIG. 2. Case 1. Spot roentgenogram of intramural tumor.

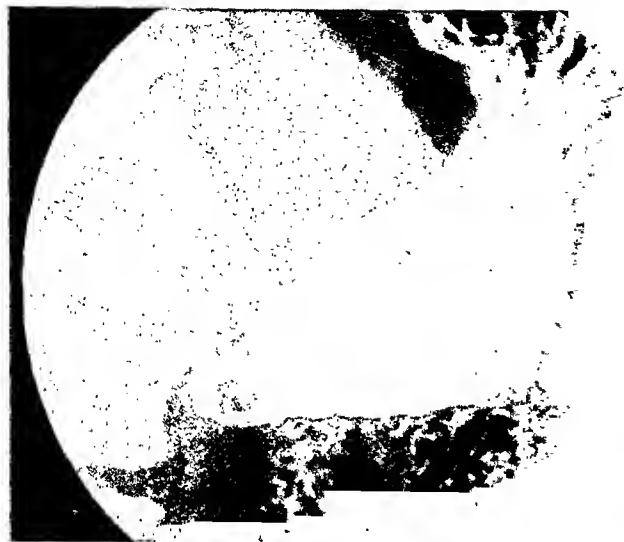


FIG. 3. Case II. Polypoid tumor of antrum.

cm. in diameter was seen in the prepyloric region. At surgery a soft, round mass, 2 cm. in diameter, was found 4 cm. proximal to the pylorus on the greater curvature. It was resected and, on study, was found to be a cyst measuring 1 by 1.8 by .8 cm. filled with clear, watery fluid. It had a base of firm white tissue 9 mm. thick which was recognized as aberrant, fairly normal appearing pancreatic tissue with the "cyst" a dilated duct. The entire tumor lay beneath the muscularis mucosa and in the muscularis proper. Convalescence was uneventful and the inguinal hernia was later repaired after which the patient was returned to duty without symptoms.

DISCUSSION

The roentgen findings in these 2 cases differed considerably. The first case was the more puzzling because of the size of the tumor and the intact mucosa. It was believed to lie in the wall, to be benign and to cause the delay in emptying. The second case presented the fairly typical elements of a polyp and was similar in all respects to the case of Faust and Mudgett.¹ In neither instance was the true nature of the condition recognized preoperatively. The lesion was undoubtedly the cause of the symptoms in the first patient and an incidental finding in the second.

SUMMARY AND CONCLUSIONS

1. Two cases of aberrant pancreas in the antrum of the stomach are reported.

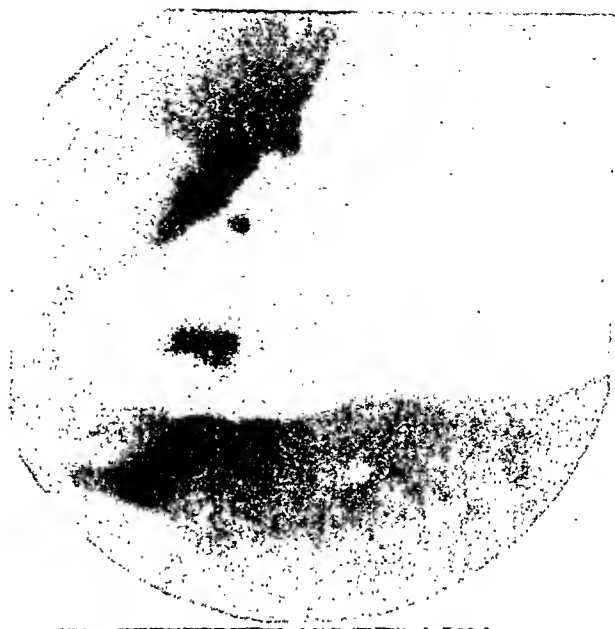


FIG. 4. Case II. Spot roentgenogram showing polypoid tumor.

2. The cases which have appeared in the literature to date are tabulated.

3. The suggestion is made that ectopic pancreatic tissue be considered in the differential diagnosis of apparently benign intramural tumors in the upper gastrointestinal tract as visualized roentgenographically.

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REFERENCES

1. FAUST, D. B., and MUDGETT, C. S. Aberrant pancreas, with review of the literature and report of a case. *Ann. Int. Med.*, 1940, 14, 717-728.
2. MITCHELL, N., and ANGRIST, A., Myo-epithelial hamartoma of the gastrointestinal tract (Clarke). *Ann. Int. Med.*, 1943, 19, 952-964.
3. TROLL, M. M. Aberrant pancreatic and gastric tissue in the intestinal tract. *Arch. Path.*, 1944, 38, 375-380.
4. CHAPMAN, J. L., and MOSSMAN, H. W. Annular pancreas accompanied by aberrant pancreatic nodule in the duodenum. *Am. J. Surg.*, 1943, 60, 286-288.
5. BROWN, S., FLACKS, K., and WASSERMAN, P. Aberrant pancreatic tumor in the duodenal wall. *Radiology*, 1944, 43, 385-386.
6. BALLINGER, J. Hypoglycemia from metastasizing insular carcinoma of aberrant pancreatic tissue in the liver. *Arch. Path.*, 1941, 32, 277-285.

THE PANCREAS AND ITS RELATION TO PSORIASIS, ECZEMA AND CERTAIN OTHER DISEASES OF THE SKIN*

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WHEELING, WEST VIRGINIA

THE importance of the pancreas in the human economy has its counterpart in diseases and abnormal functions. Much of this conduct of the gland we have been slow to recognize. Observations point to the pancreas as being responsible for psoriasis, eczema and certain other diseases of the skin.

Functionally the pancreas produces an external alkaline secretion containing the digestive enzymes trypsin, amylase and lipase. This secretion, well over one liter per day in amount, is conducted by way of the pancreatic duct, which usually terminates an orifice common to it and the bile duct to the duodenum. According to Meakins¹² "The external pancreatic secretion is stimulated by a hormone produced in the mucous membrane of the small intestine which is called secretin." He says, "Therefore, if for any reason the mucous membrane of the small bowel be grossly destroyed or atrophied, pancreatic activity may be impaired." The cells of Langerhans produce the internal secretion.

Pancreatic secretion, according to Glasser,⁸ is usually isotonic with plasma and the distribution of the cations resembles fairly closely that of plasma. His analysis shows that sodium is the most abundant element and HCO_3 is the most prominent radical. The composition of this fluid is known to vary with the mode of stimulation and rate of flow being under nerve control of the celiac, mesenteric and splenic plexus. Glasser says further that "The energy metabolism of the pancreas has not been widely investigated. Practically nothing is known of the exact materials burned and nothing is known of the manner of application of the energy. About all that can

be said is that oxygen consumption of the gland increases with activity irrespective of blood flow."

The concurrence of cholecystitis and diseases of the pancreas has long been recognized by clinicians and surgeons. When discussing the etiology of acute pancreatitis, Portis¹⁵ says, "In 50 to 60 per cent of all reported cases of acute pancreatitis and in 78 per cent of our cases there were disease and presumably infection of the gallbladder."

On this particular subject, Tice²² adds to his own observations the benefits of reviewing one hundred and sixty-seven special articles. He states: "The symptoms of all types of chronic pancreatitis are not easy to dissociate from those of chronic cholecystitis, particularly in view of the fact that one-fourth of the patients with gallbladder disease have a coassociated pancreatic lesion." Shallow *et al.*,²⁰ in reporting their 12 cases of acute pancreatitis, state that 8 of them also showed cholecystitis.

Perhaps the one principal factor which has to do with the association of diseases of liver and pancreas lies in the somewhat free passage of one glandular secretion into the ducts of the other organ conveying digestive fluids and infection.

The normal secretory pressure of these two glands, as given by Glasser, is bile pressure 250–275 mm. of water, pancreatic pressure 200–275 mm. of water. Concerning the relation of pancreatic duct pressure to bile duct pressure Glasser states:

In a certain proportion of cases, the main pancreatic duct joins the common bile duct at the ampulla of Vater, and the two empty into the duodenum through a single orifice at the major duodenal papilla. It is thus possible for a spasm

* Presented at the Wheeling Hospital, Wheeling, West Virginia, June 21, 1945.

or edema of the distal portion of the ampulla or for a stone impacted in the ampulla to convert the common bile duct and the main pancreatic duct into a common channel. Since the secretory pressure of the pancreas is approximately the same as that of the liver, it is possible under these conditions for the bile to flow into the pancreatic duct or pancreatic juice to flow into the pancreatic common duct and hence to the gall bladder, depending on the pressure gradient at any particular moment.

Diagnosis of disease and altered functions of the pancreas remains difficult because of the location of the gland, its physical structure and its various symptomatology. Physiological chemistry has been the main approach to this subject for many years. Roentgen study of the pancreas and the adjacent organs has been very illuminating. Our inability to render the gland opaque with dyes has, however, limited these efforts. If the symptoms persist, even though roentgen examination gives a negative report, the pancreas should be suspected. Furthermore, Gubergrits¹⁰ states that diagnostic difficulties arise also from the fact that a considerable anatomic destruction of the gland may not affect its function.

It becomes apparent that in the pancreas, a gland whose pathology is already difficult to interpret, any one of its functions may be interrupted by infection by way of the gallbladder, blood vessels or lymphatic channels. Ascending infection from the duodenum is a very direct route.

Sterile bile spilling over into the pancreas produces its own characteristic reaction in this gland. Then let us inquire whether any cutaneous manifestation occurs whose etiology is now unknown, when for some reason tissue digesting trypsin becomes extravasated throughout the pancreas. Again, what can be said concerning an insufficiency of any one of the allimportant external digestants—trypsin, amyllopsin or lipase? When the very tissue growth and maintenance of the body is endangered, here in the pancreas it is indeed paradoxical that the skin should, in part, reflect such warning.

Concerning pancreatic insufficiency, Current Comment,⁵ under title of "Abnormal secretion of the pancreas and other glands a systemic disease," has this to say: "According to Farber and his associates obstructive conditions in the pancreas early in life are associated with meconium ileus in the neonatal period and later with nutritional disturbances, in which the celiac syndrome and serious respiratory disease predominate. Farber deals particularly with the pancreas, the respiratory system, the liver and the salivary glands of young children with pancreatic insufficiency. In the pancreas he found more or less complete atrophy of the exocrine parenchyma associated with and apparently due to the accumulation of inspissated secretion in the acini and in the variously dilated ducts. In what seemed to be the early stage of the process the acini and smaller ducts contained eosinophilic homogeneous masses that would cause obstruction to the outflow of pancreatic juice as suggested by Wolbach some years ago. In such cases the duodenal contents did not give evidence of the activity of pancreatic enzyme. In the patients with the symptoms and lesions of obstructive pancreatic achylia who lived more than a few months after birth, both the lungs nearly always showed effects of obstruction of the trachea, the bronchi and the bronchioles by thick, tenacious mucoid and mucopurulent material. The mucous glands of the trachea and bronchi were distended with material like that in the pancreatic acini and ducts. That was the case also in the salivary glands and the mucous glands of the esophagus, the duodenum, the gallbladder and the jejunum. The microscopic changes in the liver duplicated in all important findings the lesions in the pancreas, even to the color and appearance of the inspissated secretions." The pancreas may be only one of many glandular structures of which the secretions are subject to physical changes of as yet unknown nature that cause obstruction and dilatation of acini and ducts, with far reaching functional and anatomic consequences. "What

has been called cystic fibrosis of the pancreas or pancreatic fibrosis is really a systemic disease with a variety of clinical appearances, the occurrence of which depends on when the obstructive changes occur and which organs are affected." Better understanding of this disease calls for studies of the nature and causes of the alterations in the glandular secretions."

When associated with A. Judson Quimby the writer joined him in a paper entitled "Roentgen findings in the upper right abdomen, with special reference to the duodenum, gallbladder and pancreas."¹⁶ The following is a quotation from that paper:

The Roentgen and clinical findings recorded in this paper are a part of the observations made during an analysis of one thousand cases referred to us for x-ray examination of the intestinal tract. Data concerning functional phenomena in the abdomen, demonstrable by Roentgen methods, were tabulated and are submitted in the hope that special attention will be drawn to cutaneous manifestations of duodenal toxemias and the pathological and mechanical factors causing this special form of autointoxication, and that the value of x-rays in differential diagnosis of lesions of the duodenum, gallbladder, and pancreas will be further appreciated.

In recent times, we have been giving the second and third portions of the duodenum very careful consideration in our work. This has permitted us to make some observations that in some respects we regard as original, not having been able to find literature bearing directly upon this subject from the standpoint that we have observed it. This has chiefly to do with the results of delay in the drainage of the duodenum and the resulting effect upon the gallbladder and pancreas, and especially, cutaneous manifestations of duodenal toxemia. These observations have frequently permitted us to determine the existence of a pancreatitis where it was unsuspected.

Several contributors to medical literature have suggested the importance of duodenal toxemia or duodenal poisoning, but as far as we have been able to find in reviewing the subject, no attention has been given to some of the most marked clinical manifestations of duodenal toxemia. Our observations have led us

to believe that the delay in the duodenum brings about organic changes in the pancreas and gallbladder, together with their drainage canals, and that serious constitutional toxemias are brought about and that one of the most marked manifestations of this poisoning is in the skin.

During the past three decades I have pursued a follow-up course concerning the pancreas and its relation to certain diseases of the skin. Observation from roentgen studies, clinical course of the cases and the result of therapeutic measures employed leads to the conclusions that (1) psoriasis is a disease of the skin due to infection of the pancreas, (2) eczema (endogenous) is due to insufficiency of pancreatic fluid.

Psoriasis, considered in more detail, comprises approximately 3 per cent of all cutaneous affections according to authorities. Ormsby and Montgomery's¹⁴ statement that "Heredity is seemingly a factor in a considerable number of cases," is not inconsistent. Frequently in this series of 25 cases of psoriasis, the history of the patient revealed some source of infectious disease, a gallbladder attack, perhaps a recent confinement, or even the administration of a vaccine.

A common channel of infection is explained in Gray's Anatomy.⁹

Glands which are found along the course of all the branches of the abdominal aorta empty into and belong to the group of pre-aortic glands. The pre-aortic glands receive vessels from the juxta-aortic glands and from all the glands along the mesenteric vessels and the coeliac axis and its branches, and receive lymph from the stomach, intestines, liver, pancreas, and spleen. They anastomose with each other.

The pelvic lymph drainage is a part of this system.

Agnes Savill,¹⁸ a noted English dermatologist, says:

In one of my patients patches of obstinate psoriasis of the scalp and body gradually subsided without any local treatment, during a course of intra uterine ionisation and pelvis diathermy. As the profuse uterine discharge

was thus cured, the skin lesions gradually cleared spontaneously.

Physical examination of each and every patient in this series of cases of psoriasis revealed tenderness of the pancreas. For palpation the standing position is preferred. Distress is elicited by deep pressure on head of gland—symptoms diminish toward the left side of the body. I have had the opportunity of seeing a few psoriatic patients operated upon. The surgeon each time has described the pancreas as being enlarged and more dense than usual. A patient having extensive areas of psoriasis is a poor risk for surgery in the upper abdomen.

Eczema is the disease of the skin for which patients most often seek medical advice. Statistically, eczema has comprised 30 to 35 per cent of listed causes of skin diseases. So say Sutton and Sutton.²¹

The etiology at once becomes of prime importance. Ormsby and Montgomery make an interesting statement concerning heredity. Eczema, they say, "is not in itself hereditary, but a tendency to the disorder may be transmitted from parent to child, though occasionally not made manifest until adult life. Stokes states that at times there is a state of inborn tissue lability and hyperirritability that is hereditary in character. Eczema may occur in individuals who are in every respect perfect examples of health, but in many instances it is associated with some disturbance of the general economy, and it often occurs in persons who are affected with some systemic disorder."

Familial characteristic or tendency amounts to 15 per cent of the 200 cases of eczema which form the basis of this report. The history reveals that a close blood relative has diabetes or the patient himself has glycosuria or at one time sugar was found in the urine.

Having briefly considered heredity, we should next examine the subject of nourishment. Volumes have been written on foods and their relation to disease. Heretofore to no single item or class of food went the

blame of producing eczema. After taking food, it is assumed that every gland and organ functions normally to digest the food. This is not true. Eczema is a disease of the skin due to pancreatic insufficiency—insufficiency of amylopsin, the principal digestant of carbohydrates. The history obtained from the majority of these patients reveals that one or more carbohydrates have been taken in excessive amounts. This fact may not be elicited in a few cases where all body functions are at a low ebb. In this series of cases amylopsin insufficiency has not been proved. However, the treatment carried out and the clinical course of the disease fully justify the assumption of this etiology.

Diet restriction is no difficult problem to have the average patient understand. Strict abstinence from *all* carbohydrates can be directed on a printed list.

Indications also point to additional diseases of the skin whose etiology is now declared unknown, but whose clinical group of symptoms is actually due to disease of the pancreas.

Dermatitis herpetiformis is an infection of the pancreas. The following is an illustrative case:

Mr. K., aged fifty-nine, a watchman, had usual health until a severe attack of hemorrhoids occurred in November, 1944. A few days later a serious and somewhat general skin eruption appeared. Itching was extreme. The correct diagnosis had been established elsewhere. An examination, in April, 1945, of this man showed typical and extensive lesions including a characteristic eruptive area overlying the sacrum. Tenderness of the pancreas was pronounced.

Treatment. The most extensive eruptive areas were given roentgen exposures. Panteric compound tablets were prescribed before meals. Lotion for itching was used freely. Sedative capsules were taken for sleep. Improvement was noted. In May, 1945, the patient was in Wheeling Hospital for penicillin treatment. During five days 120,000 units were given. The skin promptly improved and the patient was more comfortable. Pancreatic tenderness subsided. Under subsequent treatment with roent-

gen rays and pancreatic substance, improvement continued until nearly all the skin lesions disappeared. In July the patient returned to his usual work.

Carpenter and Hall² had the opportunity of studying 6 cases of dermatitis herpetiformis in Service men aged twenty to thirty-two years. In regard to penicillin they summarized by saying that penicillin therapy was of immediate value in the treatment of 6 patients with dermatitis herpetiformis. However, new lesions reappeared within hours to days of its discontinuance. No more benefits were derived from the use of 1,000,000 units than from 300,000, and the authors believe that 300,000 units is the optimum dose.

With uniformly good results shown in the treatment of dermatitis herpetiformis with penicillin, it would seem that panteric compound medication is second in importance. Roentgen therapy follows.

Another personal observation was made concerning the relation of the pancreas and skin:

The use of pancreatin (trypsogen) in a case of pityriasis rosea gave the most remarkable results in all my three years of experience with this glandular substance.

The patient, a middle aged workman, had pityriasis lesions from scalp to soles of the feet. At noon he was given a small dose of roentgen rays. At one o'clock he was given 175 gr. pancreatin in a glass of water. He had lunch at 2 P.M. At 6 P.M. he took 25 gr. of pancreatin before more food. At 7 P.M. the entire skin was clear. Five days later a small group of lesions appeared on the thigh. Twenty-five grains pancreatin were taken before a meal. The lesions completely disappeared. There was no recurrence.

TREATMENT

When treating diseases of the skin additional methods must be employed to meet the newer ideas of etiology.

Psoriasis in every case of the present series revealed a pancreatitis of infectious origin. The source of infection cannot always be determined. However, in some

cases this can be learned and the cause eliminated.

A most helpful internal medication used has been pancreatin. Especially where accompanying involvement of the biliary tract is suspected enteric coated panteric compound tablets (which includes glycocholates and taurocholates sodium or ox gall) are used freely. Two or three tablets are recommended before meals. Diminished tenderness of the pancreas is soon noted. Colonic elimination is imperative. Local applications for removing scales have been most simple. Ordinary washing with soap will soften and remove much debris. This may be preceded if desired, by some bland oil. Stronger keratolytic action can be attained from salicylic acid in solution or ointment. Precipitated sulfur ointment is beneficial. When psoriasis with scales is present, an aqueous lotion of salicylic acid and bichloride is efficient and decidedly more acceptable to the patient than an ointment.

Years of experience in the application of roentgen rays in the treatment of psoriasis places this method as the most important of all local treatments. This fact is best expressed by Ormsby and Montgomery who say, "Radiotherapy is a clean, efficient and most valuable method of local treatment. In the majority of instances psoriatic lesions disappear with more certainty and with much greater rapidity under roentgen-rays than with any other local measure. The rays should be employed with great caution, and a dermatitis should not be induced." On the scalp roentgen irradiation is used cautiously in only the most persistent cases. Penicillin therapy combined with pancreatin remains to be tried.

"Eczema represents the outstanding province for the use of Roentgen rays in the treatment of skin diseases" (Ellinger⁷). MacKee¹¹ says, "The x-rays have been used successfully in the treatment of eczema almost from the very beginning of Roentgen therapy."

An over-all acquaintance with radiation therapy adds definitely to the successful

application of roentgen rays in diseases of the skin. For eczema, suberythema or semi-intensive irradiation approximates the correct dosage. Experience really shows that the dosage should vary with patients and parts treated.

Internal medication is known to play an important part in the treatment of eczema, the most common of all skin diseases. Three years ago I arrived at a conclusion that eczema is due to an insufficiency of the pancreatic gland—amylopsin insufficiency.

Concurrently with roentgen therapy, 200 consecutive cases of eczema (endogenous) without any exception have been *more* quickly cleared up and very satisfactorily controlled subsequently by the free use of pancreatin. This preparation is the ordinary pancreatic substance as produced by some of our well known pharmaceutical houses. This glandular powder is given in enteric coated tablets or ∞ gelatin capsules with water, preferably before eating. Some adults take this loose soluble powder in water just before meals. For infants the powder is always given in milk or water.

The dose of pancreatin has been found to vary considerably. Error usually lies in too small a quantity. Dosage must make up the pancreatic insufficiency or treatment will be a failure. Observation has shown no ill effects from extra large doses. Administration of 300 to 400 grains per twenty-four hours shows no particular benefit. Freshness of this glandular substance adds to its efficiency.

An infant with extensive eczema should have a heaping teaspoonful—175 gr. in the twenty-four hour diet. A remarkable change has been seen in the condition of the skin within two or three days. A smaller amount will suffice as the skin clears. Some pancreatin must be added to the child's food indefinitely. Pancreatin is administered to adults in triple strength enteric-coated tablets—two tablets with water before meals. The ordinary ∞ gelatin capsule holding 8 grains of glandular substance has been a satisfactory means of administra-

tion—three capsules with water before meals are prescribed. The number taken can later be regulated according to indications.

In recent months, benefits from pancreatin therapy have been found even more striking by giving the patient a large initial dose of this glandular substance when he comes for his first roentgen treatment. The patient is given approximately 175 gr., one heaping teaspoonful of this powder in a glass of water. Initial aid to the patient's digestion, combined with the daily pancreatin taken with meals, produces a remarkable change in the skin within two or three days. The subsequent care simply requires the proper irradiation and medication until the desired results are obtained. Some patients appear to have a permanent relief from eczema.

In many cases a recurrence of the eczema is expected because of familial reasons, personal habits, etc. Under these conditions physician and patient will learn the approximate dose of pancreatin needed to compensate for the insufficiency of the pancreas. Experience shows that 10 gr. daily, taken before the largest meal, will serve to maintain a clear skin in many cases. One adult female who had eczema for twenty years found, after we cleared up the skin with roentgen irradiation and pancreatin, that one-third of a teaspoonful of glandular substance taken in a glass of water two or three times a week would keep her free of eczema.

Local treatment of eczema has been no problem after correcting the diet and supplying the pancreatic substance. A clean and pleasant lotion of calsorcine relieves itching and is drying. If the surface becomes too dry or inclined to form small fissures during the course of treatment, the patient finds comfort in some bland ointment such as cold cream containing a little phenol. A great variety of local applications has been found unnecessary.

The anatomical distribution of endogenous eczema, as noted in these cases, is of no particular interest; however, it is note-

worthy to state here that the clinical varieties encountered in this series have all responded in a like manner to this new therapy.

Will pancreatin alone clear up eczema? Nearly all cases with this disease seek treatment when they are in great distress. Pancreatin alone has not been tried, but it is believed safe to say that this substance would relieve and control the condition, but much more slowly than when combined with roentgen irradiation. Infants are treated with only pancreatin—they are not given irradiation.

COMMENT

That there is a relationship between the pancreas and diseases of the skin was originally presented by me in 1922, under the title of "X-ray Diagnosis of Chronic Pancreatitis and its Relation to Some of the Common Skin Diseases."¹⁷ At present there should be a closer correlation of the important points already brought out by various authors. A correlation of the anatomy, physical signs, clinical notes and therapeutic measures is very important.

Anatomy has an all-important bearing on the origin of some diseases of the skin. We should emphasize here the prime importance of the abdominal pre-aortic lymph glands and lymph vessels. In the anastomoses of these pre-aortic vessels with each other—a fact as old as modern anatomy—lies some of our neglected correlation concerning infection and skin diseases.

Physical signs revealed tenderness of the pancreas in every case of psoriasis and the one case of dermatitis herpetiformis. By way of contrast let it be understood that pancreatic insufficiency gives no physical signs.

Bullous skin conditions, represented in part by epidermolysis bullosa and pemphigus, are due to disease of the pancreas, it is suspected. Dermatitis herpetiformis is definitely known to be due to an infection of the pancreas.

Savill observed and briefly describes 2 cases of epidermolysis bullosa. She noted

that the blood revealed marked hypoglycemia. Both of these cases cleared up after the administration for several weeks of large doses of glucose. Both cases had widespread erythematous vesicular rash. The temperature in one case was 99°–100° F. Pemphigus is the most outstanding bullous disease. The pathologic findings in a case of pemphigus foliaceus as reported by Schultz¹⁹ are interesting. The principal abdominal findings were as follows: The spleen was considerably enlarged. The malpighian bodies appeared as well defined, opaque, yellowish nodules 1 to 3 mm. in diameter. The mesenteric lymph nodes were enlarged, firm and congested. The hilum of the spleen was united to the tail of the pancreas by a mass of chronic inflammatory tissue which contained enlarged lymph glands, one of which showed coagulation necrosis. With such an inconclusive autopsy report it is safe to say that pemphigus is most likely due to infection of the pancreas.

The case of pemphigus vulgaris reported by Covey³ is of special interest because of the etiology. This patient was a female aged fifty-three. He states that in September a dentist had extracted one carious tooth and treated a rather severe pyorrhea. In November a bullous eruption appeared over nearly the whole body. The route of this infection from the gums to pancreas seems to be satisfactorily described in Gray's Anatomy. The submaxillary and deep cervical lymph vessels and glands receive lymph from mouth tissues including the gums. In part, Gray says that "Glandular enlargement is secondary to a bacterial disease or to cancer involving the lymph-vessels which come in to the gland. The seat of disease may be distant.

"Disease of the teeth, tongue, gums, floor of the mouth, and alveolar processes may cause enlargement of the glands at the angle of the jaw." "The lower deep cervical glands occasionally enlarge secondarily to malignant growths [or bacterial disease] of the abdomen or mediastinum, but this is not due to a direct flow of lymph, as the

mediastinal glands do not send vessels to the supraclavicular glands." "It is due to blocking of lymphatic vessels and reversal of the lymph stream so that lymph containing cancerous [and bacterial] disease regurgitates."

Abnormalities of the lymphatics, as referred to by Cunningham,⁴ anastomoses of lymph vessels or regurgitation of contents could readily carry infection from the mouth to the pancreas.

Gonorrheal dermatoses are recognized and described in some detail by Sutton and Sutton. Internal circulation of gonococcus is troublesome and sometimes reaches serious proportions. Sutton and Sutton do not make clear the direct route of bacterial entrance into the system. The pre-aortic gland anastomoses explain the channel of infection. "Dawning's Case" as referred to by Sutton and Sutton "improved after the seminal vesicles and prostate, swollen and boggy, had been incised and drained." This occurrence is parallel with the disappearance of psoriasis after ridding a female pelvis of the infection.

Some additional comment is worth while on the three pancreatic enzymes, lipase, amylopsin and trypsin, and the insufficiency of these enzymes as a group in relation to diseases of the skin.

Xanthomatosis is principally an insufficiency of lipase to digest the fats. Under "Lipoaemic Deficiency" Moore's¹³ remarks, too, convey this idea of insufficiency of the enzyme lipase. Authors generally agree that xanthoma represents disturbed fat metabolism.

Dragstedt,⁶ after studying this subject, states, "It therefore may be helpful to summarize the evidence at present available which indicates that lipocaic is a specific pancreatic hormone."

"Microscopic examination shows that the histologic structure of the various types of exanthema is essentially the same though it differs somewhat according to the clinical form which the disease assumes" (Becker and Obermayer¹).

Eczeema is a carbohydrate disease.

Whether the normal carbohydrate is present in the skin in excessive amounts or a foreign carbohydrate is deposited there is not known at this time. Its presence is an irritant to the skin thereby producing eczema.

Bearing on this subject, Moore has this to say: "Of the two carbohydrates in normal tissue, glycogen and glucose, only the former is histologically identifiable. Glucose is soluble in all reagents used for the fixation of tissue, and no stain has been developed for it."

Under the subject of Diabetes, Moore again makes reference to the fact that a carbohydrate exists in the skin when he says "The epidermis in a well treated diabetic patient contains an abundant amount of glycogen, which is gradually depleted in the absence of adequate doses of insulin."

"During the past three years Pancreatin (Amylopsin) therapy, combined with radiation, has caused eczema in every patient to disappear. Control of the disease is maintained by sufficient dosage of this gland substance in like manner of controlling diabetes with Insulin."

Trypsin insufficiency is manifested in the skin by pityriasis rosea and lichen planus. Moore says that in a few pathologic conditions an abnormal protein is formed, and deposit of it in the tissue interferes with function, causing typical and at times diagnostic clinical signs. The more important one of these proteins he refers to as the substance known as amyloid. Concerning "Types of Amyloidosis," Moore divides them into four groups. Under group "(2) Primary Amyloidosis" he includes the skin among the most frequent sites involved.

While the "Pathogenesis and causal factors of formation of amyloid is still unknown," Moore favors the possibility that "amyloid or a mother substance is elaborated throughout the body and precipitated out in the organ or tissue where it is found." Among the organs where amyloid is found Moore says that lesions of the skin

appear as papules or plaque-like tumors with or without ulceration. Amyloid material has been noted at times to be of a bluish-red translucent appearance or it may transmit the color of underlying tissue, according to Moore's description.

Color of tissue produced, resulting from insufficiency of pancreatic enzymes, is worthy of note. Lipase insufficiency tissue is principally yellowish. Amylopsin insufficiency scales are white to flesh color. With trypsin insufficiency bluish to red color predominates.

In closing these comments, it may be stated that no particular reason has been encountered in embryology or physiology as to why so many pancreatic diseases are reflected in the skin. Many additional questions are in our minds concerning this organ. What happens when sterile bile overflows into the pancreatic ducts and tissue? When obstruction induces trypsin self-digestion of the gland, what disease do we find in a patient? With different bacterial infections of the pancreas, what variations of skin lesions will be seen?

CONCLUSIONS

Eczema is a disease of the skin due to insufficiency of the pancreatic enzyme amylopsin. Observations clearly indicate that disturbed carbohydrate metabolism in the skin becomes an irritant to the skin. The administration of pancreatic substance along with roentgen treatment and diet therapy has promptly cleared up all cases of eczema (endogenous). Subsequently this disease has been satisfactorily controlled by pancreatin and restricted diet.

Psoriasis is due to infection of the pancreas. As an aid to roentgen therapy, pancreatin compound is an improved medication.

Dermatitis herpetiformis, pityriasis rosea and certain other cutaneous disturbances have their origin in disease of the pancreas.

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REFERENCES

1. BECKER, S. W., and OBERMAYER, M. E. Modern Dermatology and Syphilology. J. B. Lippincott Co., Philadelphia, 1940, p. 606.
2. CARPENTER, C. C., and HALL, W. H., JR. Treatment of herpetiformis with penicillin. *Arch. Dermat. & Syph.*, 1945, 51, 241-242.
3. COVEY, G. W. Pemphigus vulgaris. *Arch. Dermat. & Syph.*, 1924, 9, 305.
4. Cunningham's Anatomy. 1903 edition.
5. Current Comment. *J. Am. M. Ass.*, July 8, 1944.
6. DRAGSTEDT, L. R. Present status of lipocaic. *J. Am. M. Ass.*, 1940, 114, 29-32.
7. ELLINGER, F. The Biologic Fundamentals of Radiation Therapy. Elsevier Publishing Co., New York, 1941, p. 28.
8. GLASSER, OTTO, Editor. Medical Physics. Year Book Publishers, Chicago, 1944, pp. 32, 889, 890.
9. Gray's Anatomy. Da Costa edition, 1905, pp. 788, 800.
10. GUBERGRITS, M. M. Functional diagnosis of the pancreas. *Klin. Med.*, 1939, 17, No. 3, 3-13.
11. MACKEE, G. M. X-Rays and Radium in the Treatment of Diseases of the Skin. Third edition. Lea & Febiger, 1938, p. 489.
12. MEAKINS, J. C. The Practice of Medicine. Second edition. C. V. Mosby Co., St. Louis, 1938, p. 748.
13. MOORE, R. A. A Textbook of Pathology. W. B. Saunders Co., Philadelphia, 1944, pp. 15, 16, 17, 37, 1090, 1094.
14. ORMSBY and MONTGOMERY. Diseases of the Skin. Sixth edition. Pp. 242, 278, 290.
15. PORTIS, S. A., Editor. Disease of the Digestive System. Lea & Febiger, Philadelphia, 1944, p. 440.
16. QUIMBY, A. J., and QUIMBY, W. A. Roentgen findings in upper right abdomen, with special reference to the duodenum, gallbladder and pancreas. *New York M. J.*, May 5, 1917.
17. QUIMBY, W. A. X-Ray diagnosis of chronic pancreatitis and its relation to some of the common skin diseases. *J. Radiol.*, 1925, 6, 186-188.
18. SAVILL, AGNES. Hair and Scalp. Third edition. William Wood & Co., Baltimore, 1945, pp. 170, 296.
19. SCHULTZ, O. T. Pathologic findings in a case of pemphigus foliaceus. *Cleveland Med. J.*, 1907, 6, 512.
20. SHALLOW, T. A., EGER, S. A., and WAGNER, F. B., JR. Conservative management of acute pancreatitis. *Pennsylvania M. J.*, 1944, 47, 1199-1209.
21. SUTTON and SUTTON. Tenth edition. Pp. 217, 963.
22. TICE, F. Practice of Medicine. Vol. VII, 1940.

TUMOR DOSAGE AND RESULTS IN ROENTGEN THERAPY OF CANCER OF THE BREAST

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THE results of roentgen therapy of cancer of the breast vary with the dosage which reaches the tumor. This in turn is influenced by the accessibility and extent of the tumor and the tolerance to the treatment. Clinical arrest of most breast cancers by roentgen irradiation requires heavy dosage. The nearer the surface and the more localized the cancer is, the smaller is the volume of normal tissue which has to be irradiated and the greater the tumor dose which will be tolerated. Thus the growth within the breast and axillary lymph nodes may be vigorously crossfired through multiple fields and a high tumor dose may be obtained. Similar dosage is not tolerated if applied to widespread metastases.

Roentgen therapy does not remove the cancer as in excision, but destroys it in situ, leaving it to the body to dispose of the debris; it thus taxes the patient's general health. Maximum roentgen-ray dosage is not well tolerated by patients suffering from debilitating ailments such as decompensated heart disease, severe diabetes, chronic alcoholism, and so forth.

Material. In an effort to clarify the relation between tumor dosage and results of roentgen therapy, we studied the clinical histories of 206 patients with cancer of the breast irradiated with different roentgen-ray doses at the Presbyterian Hospital, New York, and some time previously, a number of breast cancers with metastases at Montefiore Hospital, New York.

Tumor Dosage of 300-2,300 r—Postoperative Roentgen Therapy. The first series of cases studied at the Presbyterian Hospital consisted of 78 patients receiving roentgen therapy after radical mastectomy between 1923 and 1929.

Within a few months and not longer than six months after radical mastectomy, the patients

were given 400 r/o, 130 kv., 0.25 mm. Cu, 1 mm. Al, 40 cm. target-skin distance, each to the operated chest wall, anterior surface of the adjacent axilla, supraclavicular region and opposite axilla. This series of treatments was repeated at least once in four to eight weeks, and in some, several times at two to three months' intervals. The total roentgen-ray dosage in a year thus did not exceed 2,000 r/o. At the level of the internal mammary lymph nodes this would be reduced to a tumor dose of perhaps from 300-1,300 r and at the highest raised to 2,300 r in the region of the most superficial supraclavicular lymph nodes.

The inadequacy of this treatment may be gleaned from the fact that 8 of the cases of skin metastases occurred in a previously irradiated mastectomy area. While retrograde extension may have taken place from the periphery of the treated field, it seems more likely that the cancer cells persisted in situ in spite of this roentgen radiation dose.

The survival of the 78 patients did not seem to be influenced by the treatment as given. The clinical course following roentgen therapy varied according to the preoperative extent of involvement in the breast and axilla, exactly as in patients who had not received any postoperative treatment.

In modern postoperative roentgen therapy with 200 kv. and 0.5 to 2 mm. Cu filter, one rarely gives more than 1,500-2,500 r/o in four to six weeks to the parasternal area and 2,500-4,000 r/o to the anterior aspect of the supraclavicular region. Some also irradiate the axilla; we have not done so, as we have seen very few recurrences in this location, at the Presbyterian Hospital. Dosage in the parasternal region is reduced because of the fear of producing irradiation pneumonitis and also of injuring the poorly vascularized postmastectomy skin flap. There is a great

deal of divergence of opinion as to what such dosage can accomplish in cancer of the breast. It may be that it is sufficient to delay somewhat the appearance of skin recurrences in the mastectomy area, if cancer tissue has been left at the time of mastectomy. In the light of some studies quoted further on, however, it seems like very little dosage, indeed. In any case, it does not seem logical to consider the large dosage which may be brought to bear on the accessible breast tumor as inadequate, therefore indicating mastectomy, yet hope that the lesser dosage reaching the inaccessible metastases in the internal mammary and anterior mediastinal chain of lymph nodes will destroy metastases in these locations. Optimistic claims of the results of post-operative roentgen therapy are often based on a mistaken clinical diagnosis of persisting cancer and usually do not take into consideration the question of the dosage which reaches the site of the suspected metastasis.

Roentgen therapy after radical mastectomy at the Presbyterian Hospital is limited to cases where the preoperative estimate of the extent of the cancer has been proved inadequate by the microscopic examination of the removed breast and axillary lymph nodes, or when there is clinical evidence of persisting or recurring disease.

Tumor Dosage of 4,500 r—Preoperative Irradiation and Roentgen Therapy Alone. The second series of patients investigated comprises 82 patients with cancer of the breast treated between 1933 and 1937. Thirty-eight of these patients were irradiated preoperatively, a few days to a year prior to radical mastectomy, and 44 non-operated patients were treated by roentgen irradiation alone. The tumor and a wide margin of adjacent breast, wherever possible, was crossfired through each of the four quadrants of the breast.

We employed 200 kv., 0.5 to 2 mm. Cu, or Thoraeus filter, 50 cm. target-skin distance, and tangential roentgen-ray beams skimming along the chest wall in order to avoid the lungs as much as possible. The treatment took about

six to eight weeks. In some cases as high as, 2,000 r/o was given to each of the four breast fields and 2,000 r/o each to an anterior, posterior and direct axillary field. In most, weaker roentgen-ray dosage was administered and on the average a tumor dose of less than 4,500 r was obtained. The size of the fields varied from 8 by 10 to 10 by 15 cm., depending on the size of the tumor and the breast or axilla.

The cancer had become locally extensive in the majority of cases prior to treatment. In 47 of the 82 cases, the diameter of the primary breast tumor was 6 cm. or more, in 9 it was 3 cm. or less, in the others it varied in size between these extremes. While only 1 of the 9 small tumors failed to be markedly reduced by the treatment, this occurred in two-thirds of the larger tumors. Invasion of the axillary nodes was diagnosed clinically in all of the 82 patients and was corroborated microscopically in 31 of the 38 preoperatively irradiated patients. In 18 of the 44 (41 per cent) non-operated patients, skeletal or lung metastases were discovered on admission, 5 others had deep ulceration of the breast, 5 had satellite breast tumors, and 17 had marked edema or fixation of the breast. It is not surprising, therefore, that only 1 of these patients survived five years. This was a patient with an operable breast tumor 2 by 3 by 2 cm. and a palpable axillary node 1 cm. in diameter, who was mistakenly thought to have skeletal metastases. She received a tumor dose of 7,100 r to the breast and 5,462 r to the questionable axillary lymph node. She was first treated in November, 1937, and was free of disease in January, 1946.

The local disappearance of the primary tumor following roentgen therapy did not influence the course of the disease in patients with distant metastases. This disappearance of the local tumor was observed more often in the more cohesively and slower growing well differentiated tumors (9 of 11) than in the more diffusely and faster spreading, poorly differentiated cancers (13 of 21) and thus, indirectly, it was a favorable prognostic sign.

Irradiation Changes. Retrogressive irradi-

ation changes were best studied in 9 breasts in which the microscopic appearance of the tumor removed at biopsy, before irradiation, could be compared with that in the specimens obtained at mastectomy, from two days to over a year after the conclusion of roentgen therapy. There were noted vacuolization, pyknosis, swelling of the cells and nuclei, atypical mitoses, reduction in the number of mitoses and sclerosis of the stroma. In spite of the large roentgen-ray doses administered to these tumors, however, recognizable tumor cells were found in all mastectomy specimens. In some breasts, in which tumor could not be seen on gross section, only a few poorly stained cancer cells were found on most careful microscopic examination of many sections. In others, which also failed to reveal tumor on gross section, islands of well preserved cancer cells were easily demonstrated. While there was some overlapping, it was clear that the larger the tumor dose, the greater was the evidence of damage to the cancer and to the irradiated normal tissues. In most cases, the interval between roentgen therapy and mastectomy was a little over a month but in 1 case in which the tumor dose was 4,500 r, it was over a year. This was the case in which the most pronounced irradiation effect was seen, as after a careful search, only 20 poorly stained cancer cells could be demonstrated. The fact that cancer persisted after a tumor dose of 4,500 r is interesting in view of Halley and Melnick's findings of primary regression followed by renewed growth, after tumor doses of 2,400-3,300 r; and Harris's demonstration of persisting cancer after tumor doses of about 4,500 r. It corroborates our belief that such doses are too low to destroy cancer of the breast completely and will produce only temporary growth restraint.

Because of the experience with this group of cases it seemed desirable to administer larger tumor doses than 4,500 r in order to obtain a more permanent clinical arrest of cancer of the breast.

Tumor Dosage of 6,000 or over—Roentgen Therapy as the Only Treatment. During

1938, 1939 and 1940, 46 patients with non-operated cancer of the breast were treated solely by roentgen therapy in an attempt to arrest the growth.

The treatment took two to three months and tumor doses of 6,000-8,000 r (in a few a little higher) were administered. To the 2,000 r/o to each of the four quadrants of the affected breast, as described for the second series, were added another 1,000-2,500 r directly over the tumor in order to raise the tumor dose to 6,000 r or more. Each axilla was crossfired with 2,500 r/o through an anterior and posterior axillary field and with 2,500-3,000 r/o through a direct axillary field. The daily dose usually was 150-200 r to two opposing breast or axillary fields. The size of the fields varied from 8 by 10 to 10 by 15 cm., depending on anatomical indications.

The difficulty of controlling axillary metastases by roentgen therapy as compared to arresting the primary tumor in the breast has been frequently emphasized. Part of this difficulty is due to the smaller tumor dose usually given to the axilla. It is difficult to deliver through three axillary fields as much tumor dosage as through four to five breast fields. For this reason the axillary fields in this series usually had to be exposed to 2,500 r/o and sometimes to 3,000 r/o. This yielded tumor doses in the axilla from 5,500-8,150 r in 9 of the 10 five year cases discussed later on and helped greatly in arresting the disease. In the tenth, the axilla was not irradiated through an error. Axillary nodes were not palpable before nor since the treatment. The patient presented a 7 cm. fungating recurrence in the inframammary fold, following a local excision and radium therapy at another hospital and has been clinically well since August, 1939, following a tumor dose to the breast of 5,500 r.

The large dosage used in these cases resulted in telangiectasia in some instances and in a few, in irradiation sclerosis. In most, however, only slight sequelae were seen which did not cause great discomfort. In 2 or 3 patients, slow healing ulcerating radiodermatitis and chronic edema of the arm resulted. Individualization and a low

daily dose helped in preventing serious sequelae.

Most of the patients had extensive involvement of the breast and axilla on admission. The breast tumors varied in size from 3 to 10 cm. Palpable axillary nodes were present in all but one patient.

Gross regression of the tumor in the breast and axillary lymph nodes did not influence the clinical course of the disease in cases in which at the time of admission or soon thereafter, there was evidence of

in 1 the cause of death was undetermined. Among the 8 in whom the breast tumor persisted grossly in spite of 6,000 r tumor dose to the breast, 4 showed cutaneous and subcutaneous en cuirasse involvement peripheral to the irradiated field. It might be speculated whether the persistence of the tumor was due to retrograde extension into the irradiated area or whether the tumor never disappeared. In 2 cases with multiple nodules, the irradiated fields definitely did not include the entire disease in the breast.

TABLE I
TUMOR DOSES IN TEN CASES CLINICALLY FREE FROM CANCER FOR FIVE YEARS

Patient	Breast Tumor		Axillary Lymph Nodes	
	Size of Tumor cm.	Tumor Dosage roentgens	Size cm.	Tumor Dosage roentgens
St.	8×10×4	7,600	2×2×1	6,970
Pr.	10×10×6	6,061	2×2×2	5,770
Sp.	7×3×4	5,500	0	0
El.	4×4×3	8,275	3×2.5×1.5	7,875
Ell.	3×3×2	6,325	4×5×3	8,150
McGl.	7×7×6	6,400	2×2×1	6,000
Kam.	2×3×2	7,100	5×6×3	6,700
Das.	7×7×3	7,200	2×2×1	6,000
Rob.	5×6×3	6,800	4×2×2	6,670
She.	6×5×4	5,860	2×1×1	5,625

cancer spreading subcutaneously, en cuirasse, or when there were distant metastases.

Fifteen cancers of the breast were given tumor doses of less than 5,500 r, and cancer persisted grossly in all of these. Thirty-two received tumor doses of 5,500, 6,000 r or over. In only 8 of these did cancer persist locally. Of the 23 patients whose tumor disappeared clinically from the breast, 14 are dead and 9 are free from clinical evidence of cancer for over five years since roentgen therapy. Of the 14 dead, 4 died of cardiovascular disease without clinical evidence of cancer. One of these died five years and four months after roentgen therapy, thus raising to 10 those patients free from clinical evidence of cancer for over five years.

Details of the tumor doses in these 10 cases are given in Table 1.

Of the remaining 10 deaths, 3 were due to pulmonary, 6 to skeletal metastases and

One huge cancer did not change the slightest in spite of 6,000 r to the tumor.

The important fact remains, however, that with a tumor dose of about 6,000 r or over, 23 of 31 cancers of the breast, most with axillary lymph nodes, disappeared clinically, and in 10 of these, cancer could not be demonstrated clinically five years later.

We have as yet not had the opportunity to do a mastectomy five years after treatment to corroborate the absence of microscopic evidence of cancer. It may be that viable cancer cells are buried somewhere in the sclerotic depths of these breasts and that growth may some day again become active. In a patient who died of metastases seven months after her breast had received a tumor dose of 7,000 r, microscopic examination of this heavily irradiated area revealed well stained cancer cells. Grossly, the tumor had disappeared.

We, therefore, do not recommend the abandoning of radical mastectomy in cases which are operable. By radical mastectomy one may definitely cure those cases in which the entire disease is limited to the excised breast and axillary lymph nodes. Unfortunately, the frequency with which distant metastases follow this operation shows that the preoperative estimates of the extent of breast cancer are frequently inaccurate and that even the most radical mastectomy is often done too late to remove the entire disease. Only by the most rigid selection of cases for operation can mistakes be avoided.

Our criteria of inoperability at the neoplasm clinic of the Presbyterian Hospital as postulated by Haagensen and Stout are as follows:

1. When the carcinoma is one which developed during pregnancy or lactation.
2. When extensive edema of the skin over the breast is present.
3. When satellite nodules are present in the skin over the breast.
4. When intercostal or parasternal tumor nodules are present.
5. When there is edema of the arm.
6. When proved supraclavicular metastases are present.
7. When the carcinoma is the inflammatory type.
8. When distant metastases are demonstrated.
9. When any two, or more, of the following signs of locally advanced carcinoma are present
 - (a) Ulceration of the skin.
 - (b) Edema of the skin of limited extent (less than one-third of the skin over the breast involved).
 - (c) Fixation of the tumor to the chest wall.
 - (d) Axillary lymph nodes measuring 2.5 cm., or more, in transverse diameter, and proved to contain metastases by biopsy.
 - (e) Fixation of axillary lymph nodes to the skin or the deep structures of the axilla, and proved to contain metastases by biopsy.

Patients presenting any of the above criteria of inoperability are referred for roentgen therapy immediately after corroboration by biopsy and are not ever

operated on again, except as a palliative procedure to remove a sloughing mass, in case of failure of roentgen therapy. We do not think that an inoperable case ever becomes operable, after irradiation, in the true sense of the word.

Roentgen Therapy of Metastases. Because of the inclusion of large volumes of normal tissue, tumor doses in roentgen therapy of disseminated metastases are small and accomplish correspondingly only temporary regression or restraint of the growth. The therapeutic result depends on the location, accessibility and extent of these metastases and the local and general resistance of the patient.

Roentgen Therapy of Skin Metastases. In skin metastases, for instance, a dose of 4,500-5,000 r may be tolerated if the size of the involved area is 4 cm. or smaller. Unfiltered roentgen radiation with 100 kv. or lower voltage is commonly employed for this purpose, unless the skin nodules are along the sternal border and it is thought that they are extensions from metastases in the internal mammary or anterior mediastinal lymph nodes. In that case, 130 kv. and 5 mm. Al or 200 kv. and 0.5 mm. Cu are used. If a large area is to be irradiated, as for instance in widespread cutaneous and subcutaneous en cuirasse invasion, dosage, of necessity, is smaller. In exceptional cases even cancer en cuirasse may be controlled for a long time if the growth tends to spread slowly and if the advancing edge of the cancer can be included in the field of irradiation.

In a patient with a slowly progressing cancer en cuirasse involving the mastectomy area, the cancer was arrested for three and a half years by the administration of "7 cycles of low voltage x-ray therapy" given over a period of six months.

Most patients with extensive skin metastases, however, have usually spread so far afield when they come for treatment, that the limited area exposed to roentgen radiation does not include all of the local extensions. In most of them, skeletal and pulmonary metastases are also present so

that local regression of the skin metastasis has little influence on the survival of the patient.

Roentgen Therapy of Pulmonary Metastases. Irradiation of widespread pulmonary metastases is usually of little value as one rarely gives more than 1,000–2,000 r and as the process in most cases has already spread beyond the irradiated area. Significant regression of pulmonary metastases is observed chiefly in cases in which the involvement is limited to the periphery of one lobe and where tumor doses of 2,000–2,500 r will be tolerated.

Roentgen Therapy of Liver Metastases. Because of low tolerance in the region of the liver, roentgen therapy of hepatic metastases is limited to a tumor dose of a few hundred roentgens, to perhaps 1,000 r. This results in a slight reduction of pain and in the size of the metastases. Liver metastases in cancer of the breast occur chiefly in the terminal stage of the disease and usually mean death within a few months.

Roentgen Castration and Skeletal Metastases. Relief of pain and recalcification of skeletal metastases are often obtained by producing an artificial menopause with a tumor dose of about 600 r to the ovaries. We recommend this treatment only in patients with cancer of the breast who have evidence of distant metastases. We do not use it routinely otherwise. We also do not think it logical to administer roentgen treatment to the ovaries in patients past the menopause.

Roentgen Therapy of Skeletal Metastases. Irradiation of the ovaries should not be relied on solely to take care of skeletal metastases, but, in addition, painful areas should be irradiated directly. In widespread skeletal involvement it is not possible to irradiate all metastases. Total body irradiation is limited to about 300 r as shown by experience in cases of Hodgkin's disease and lymphosarcoma. This certainly is insufficient to destroy cancer of the breast. If there are several moderately sized metastases, each may be given 1,000–1,500 r for relief of pain. On the other hand, if

only a single metastasis is evident, much higher dosage may be administered and a more prolonged growth restraint obtained:

A tumor dose of 2,500 r to a collapsed eighth dorsal vertebra caused this to recalcify. This remained the only metastasis for eight years, permitting attention to household duties, driving a car, etc., in a patient who had had a radical mastectomy four years previous to the involvement of the spine.

Involvement of the brain and spinal cord are mostly extensions from or compression by skeletal metastases. They usually occur in the terminal stages of the disease, and though temporary regression may be obtained by doses of 1,000–2,000 r, the gain is only slight since the patients die within a few months from generalization of their metastases.

Natural Clinical History of Untreated Cancer. In irradiation of widespread metastases, some metastases usually remain untreated, either because the patient is unable to tolerate the treatment, or as the metastases are not recognized. For instance, breast cancers tending to grow rapidly and spread diffusely may not be started on treatment until after the occurrence of unrecognized and therefore untreated metastases. It must be assumed that skeletal and pulmonary metastases after radical mastectomy occur before the removal of the source of these metastases, i.e. the primary breast tumor and axillary lymph nodes. The clinical course after roentgen therapy in widely extending or metastatic cancers does not depend so much on the tumor dosage reaching any particular part of the neoplasm as on the inherent growth tendency of the untreated disease and the natural resistance of the patient to this growth. Adequate tumor dosage is more important in breast cancers with a tendency to chronic and localizing growth which may be treated, while the cancer is still confined to the breast and axilla, thus making the entire disease process accessible to roentgen therapy. Among patients with untreated cancer of the breast, 80 per cent die within

five years after the appearance of the breast tumor, while 20 per cent survive this period though they may still have clinical evidence of cancer. Five year survival after roentgen therapy in patients belonging to the latter group is of little significance whereas it is an important accomplishment in patients belonging to the 80 per cent, who, if untreated, would die within this period.

One of our patients irradiated for painful skeletal metastases had avoided all doctors for twenty-two years after she had been told that she needed a radical mastectomy. Had she had either surgery or irradiation, she might have been reported four times as a five year cure.

The better results of radical mastectomy in the more cohesively and slowly growing well differentiated cancers of the breast, as compared to the more diffusely and more rapidly spreading undifferentiated cancers have recently been re-emphasized by Haagensen and Stout in their study of 547 cancers of breast operated on at the Presbyterian Hospital. Of 53 well differentiated breast cancers 84.9 per cent were free from clinical evidence of cancer at the end of five years. Corresponding proportions for 170 partly differentiated cancers were 67.1 per cent and for 224 undifferentiated, only 28.1 per cent.

This tendency to grow more slowly may continue even after the appearance of skeletal metastases. Thus, the interval between the appearance of the breast tumor and the skeletal metastases, and from that time to death, was longer in patients with cancer of the breast graded 1, as compared to those graded 3, in an investigation of 57 such patients treated at the Montefiore Hospital, New York, and reported with Freid.

SUMMARY

The influence of tumor dosage on the clinical results of roentgen therapy of cancer of the breast has been emphasized by an analysis of the histories of 206 patients treated at the Presbyterian Hospital, New York, and a number of metastatic cases

treated at the Montefiore Hospital. The administration of a tumor dose of 5,500 r or more within three months has caused the clinical disappearance of the breast tumor and enlarged axillary lymph nodes in 24 of 32 patients (1 treated in 1937). Eleven of these 24 cases in whom the disease, though inoperable (1 operable), appeared limited to the breast and axillary lymph nodes, or about one-third of the 32 patients receiving this dose, were free from clinical evidence of cancer five years after roentgen therapy.

It is possible that, in spite of this clinical result, viable cancer cells may be locked up in the sclerotic depths of these heavily irradiated breasts and that at some time they may again start to grow actively. In 8 of 32 cases tumor persisted grossly in the breast in spite of this dosage. We therefore do not suggest substitution of roentgen therapy for radical mastectomy in strictly operable cases. There is no doubt, however, that many radical mastectomies are done on patients with locally inoperable tumors, though the disease appears to be confined mainly to the breast and axillary lymph nodes. It is these cases which should be treated by roentgen therapy in preference to the less inclusive radical mastectomy. Regression of an adequately irradiated portion of a cancer does not affect further progress of other portions of the growth which are under-irradiated or untreated. Thus 9 of the 32 patients died with pulmonary or skeletal metastases in spite of the local clinical disappearance of the breast tumor.

The administration of an average tumor dose of 4,500 r may cause marked irradiation changes in the cancer yet microscopically viable cancer cells may be demonstrated in the breasts removed at mastectomy as long as one year after treatment.

Still smaller dosage such as applied to metastases or given postoperatively may restrain the growth of the irradiated cancer temporarily, but is certainly too weak to destroy breast cancer. In these cases, the natural clinical history of the untreated

cancer influences the clinical course after roentgen therapy.

Tolerance of adequate tumor dosage is influenced by the extent of the cancer, its natural growth tendency, its location and accessibility, local radioresistance of the irradiated normal tissues and the ability of the patient to support the treatment.

CONCLUSIONS

A study of the relation of tumor dosage to the clinical results in 206 patients receiving roentgen therapy for cancer of the breast at the Presbyterian Hospital from 1923 to 1940, and a number of others with distant metastases treated at Montefiore Hospital leads us to the following conclusions:

1. For cancer clinically confined to the breast and axillary lymph nodes, radical mastectomy is the treatment of choice unless there are present any of the criteria of inoperability as described. In the latter cases, it is preferable to use roentgen therapy with tumor doses above 6,000 r to the breast and axilla. Strict separation of breast cancer apparently confined to the breast and axilla into operable and inoperable cases, and treatment of inoperable cases only with roentgen irradiation, is preferable to temporizing with mastectomy plus preoperative or postoperative roentgen therapy.

2. Smaller tumor dosage applicable to supraclavicular and other metastases may result in temporary growth restraint but not in destruction of breast cancer.

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REFERENCES

1. BACLESSE, F., GRICOUROFF, G., and TAILHEFER, A. Essai de roentgentherapie du cancer du sein suivie d'operation large; resultats histologiques. *Bull. Assoc. franç. p. l'etude du cancer*, 1939, 28, 729-743.
2. BEACH, A. Effects of roentgen-ray dosage in breast carcinoma. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1941, 46, 89-95.
3. FREID, J. R., and GOLDBERG, H. Frequency, clinical course and treatment of metastases from cancer of the breast. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 50, 499-515.
4. HAAGENSEN, C. D., and STOUT, A. P. Carcinoma of breast; results of treatment. *Ann. Surg.*, 1942, 116, 801-815.
5. HAAGENSEN, C. D., and STOUT, A. P. Carcinoma of breast; criteria of operability. *Ann. Surg.*, 1943, 118, 859-870; 1032-1051.
6. HALLEY, E. P., and MELNICK, P. J. Pre-operative irradiation in carcinoma of breast; histologic study. *Radiology*, 1940, 35, 430-438.
7. HARRIS, WILLIAM. Effects of roentgen therapy in primary cancer of breast. *J. Mt. Sinai Hosp.*, 1942, 8, 606-611.
8. LENZ, M., and FREID, J. R. Metastases to skeleton, brain and spinal cord from cancer of breast and effect of radiotherapy. *Ann. Surg.*, 1931, 93, 278-293.
9. LENZ, M., FRANTZ, V. K., and KASABACH, H. H. Prophylactic postoperative roentgenotherapy for carcinoma of breast. *New York State J. Med.*, 1934, 34, 881-887.
10. LENZ, M. Roentgen therapy of cancer of breast and regional metastases; preoperative and non-operated cases. *Radiology*, 1942, 38, 686-697.
11. PETERSEN, H. G. Roentgen treatment of carcinoma of breast. *Acta. radiol.*, 1944, 25, 1-12.
12. PORTMANN, U. V. Operability versus curability of cancer of breast. *Ohio State M. J.*, 1944, 40, 742-745.



PRIMARY MALIGNANT BONE TUMORS*

A REVIEW OF CASES SEEN IN THE RADIATION THERAPY DEPARTMENT OF BELLEVUE HOSPITAL

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DURING the past twenty years 235 cases of primary malignant bone tumor were seen in the Radiation Therapy Department at Bellevue Hospital. At their initial appearance, the patients presented themselves with varying stages of disease, from very early to terminal. Of the 235 cases, 114 were too far advanced for any treatment. In this paper we will be concerned with the remaining 121 treated cases.

There has been a great deal of confusion as to the terminology and classification of bone tumors. However, with the establishment of the Commission of Registry of Bone Sarcomas of the American College of Surgery, standards were set which are generally accepted and which we will follow in this presentation. All of our cases were distributed among the following groups:

1. Osteogenic sarcoma
2. Chondrosarcoma
3. Endothelioma
4. Multiple myeloma
5. Giant cell sarcoma

Table 1 illustrates the number and percentage of each type of case.

The different types of bone tumor vary in their response to irradiation. In order of radiosensitivity they are, endothelioma, multiple myeloma, giant cell sarcoma, osteogenic sarcoma, and chondrosarcoma.

The value of radiation therapy in the treatment of primary malignant bone tumors has been a controversial subject. It

is true that rarely, even in the most sensitive type of tumor, is a permanent cure effected by irradiation. Moreover, in the more resistant types there is little appreciable change. Despite these facts, the opinion is being expressed more and more frequently from authoritative sources that the best hope of cure for patients lies in the combination of intensive radiation therapy

TABLE I

DISTRIBUTION OF MALIGNANT TUMORS ACCORDING
TO CLASSIFICATION

Type of Tumor	No. of Cases	Percentage
Osteogenic sarcoma	45	37
Chondrosarcoma	8	07
Ewing's tumor	32	26
Multiple myeloma	18	15
Giant cell sarcoma	18	15
Total	121	100

and surgery. This has been our impression, and experience has borne out its veracity.

The following is a brief outline of the procedure followed in working the treatment of a patient. First, a case history is taken and physical examination is made. Special attention is given to the duration of symptoms or signs, the presence or absence of pain, whether a mass is palpable, and if so, the rate of growth, whether or not trauma preceded the onset of disease, and whether previous treatment had been given. A careful laboratory study is done. Urine

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is examined for Bence-Jones protein. Blood studies include complete blood count, Wassermann test, sugar, calcium, and sedimentation rate. All indicated roentgen examinations are done; including studies of the local area and all sites of possible metastases.

When these preliminary studies are done, biopsy is considered. Often a conclusive diagnosis is established without pathological examination. However, when there is doubt, we believe that biopsy should be done. In some cases a limb may be saved and therapy instituted for a nonmalignant condition. When the presence of a malignant tumor is confirmed, intensive radiation therapy is given, and if the tumor is accessible amputation of a limb or radical excision is done.

The technique of irradiation varies with the individual case. In an extremity where amputation is to be done, the skin is disregarded over the local area and high voltage therapy is given, cross firing through fields extending well beyond the margins of the tumor. Where immediate amputation has been contemplated, dosage as high as 4,000 r per field, treating each of two fields with a dosage of 300 r per day. In tumors of bone where surgery cannot be done the parts are treated by fractional high voltage roentgen irradiation to skin tolerance. Similar treatment is administered to the regional lymph nodes and metastatic areas when detected. When the skin has recovered, allowing an interval of two to three months, therapy may be repeated to skin tolerance. In the average individual, depending upon the size of field and the individual reaction of the patient, the tolerance will be 2,100 to 3,000 r per field.

OSTEOGENIC SARCOMA

Osteogenic sarcoma has its origin in cells which are the precursors of normal bone, the osteoblasts. There are two chief types, the sclerosing osteogenic sarcoma and the osteolytic osteogenic sarcoma. Histopathologically, they may consist of round cells, spindle cells, or a combination of both. Giant cells are frequently present. How-

ever, in contradistinction to giant cell tumor, the giant cell does not predominate.

The majority of patients were under twenty years of age. However, there was a surprisingly large group who developed the osteolytic type of sarcoma at a later age. These often ran a more benign course, as did Case 1. The usual case is one with less than one year's history of pain and swelling. Often a pathological fracture occurs. If untreated, the patient dies within a year. An early case with an accessible tumor stands about a 25 per cent chance of cure if amputation is done. Others may have their lives prolonged.

In our series there were 45 cases of osteogenic sarcoma. It will be noted that the number of cases and patients over forty years of age was high. The incidence of osteogenic sarcoma per decade is noted in Table II. Most of our patients showed

TABLE II

AGE INCIDENCE OF OSTEOGENIC SARCOMA

Age Years	No. of Cases
0-20	22
20-30	5
30-40	3
Over 40	18

evidence of metastases and received only irradiation. Those who showed no evidence of metastatic lesions were treated either by amputation or excision, combined with irradiation. Coley's serum was used in many cases, but we could see no appreciable difference in our results. The results are outlined in Table III.

CASE 1. This is an example of a patient with the osteolytic type of osteogenic sarcoma who survived eleven years with radiation therapy alone. J. B., female, white, aged twenty-six, was admitted on February 9, 1931, with a fracture of the left femur. She stated that during March, 1930, in the third month of her third pregnancy, she had developed pain in her left thigh. A private physician roentgenographed this area and told her that she had a defect in her femur which was common in pregnant women. She was permitted to carry to term. Three weeks post partum, the patient sustained a fractured

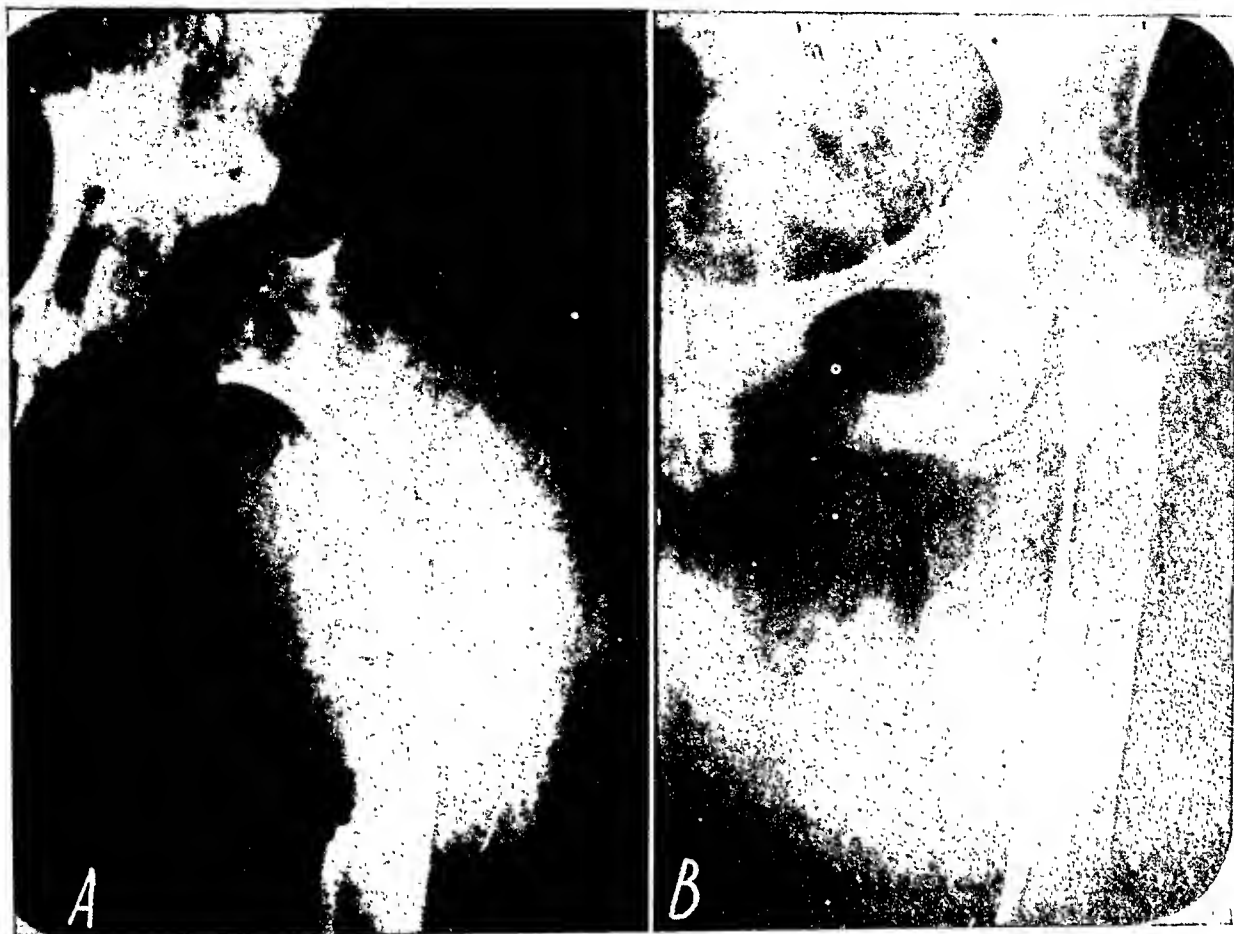


FIG. 1. Case 1. Osteogenic sarcoma. *A*, appearance at time of admission, showing destructive lesion of the upper third of left femur. *B*, following radiation therapy, showing regeneration of bone.

left femur and was put into a spica cast. Six weeks later, when there was no evidence of regeneration of bone, she was referred to Bellevue Hospital. At the time of admission, roentgen examination revealed a destructive lesion of the upper third of the left femur. The cortex was eroded and only spicules of bone were present at the site of pathology (Fig. 1 *A*). Biopsy revealed a spindle cell sarcoma con-

taining many giant cells. Because of the location of the tumor, radiation therapy was instituted, together with Coley's serum. By July, 1931, sclerosis was perceptible, and subsequently progressed to almost complete regeneration (Fig. 1 *B*). In September, 1931, a chest roentgenogram revealed two rounded areas of increased density in the right lung, one in the first anterior interspace and the other at the cardiophrenic angle. Radiation was given to these areas and to the primary site of tumor. For the next five years the patient was comfortable. Two inches of shortening of the left thigh caused her to walk with a limp. In January, 1936, she returned, complaining of shortness of breath. A chest roentgenogram revealed a dense circumscribed mass in the mediastinum extending from the upper border of T₅ to the lower border of T₁₀. This lesion disappeared under high voltage roentgen therapy. At the same time the left thigh was irradiated. She remained well until February, 1941, when she returned complaining of respiratory distress and an open draining sinus

TABLE III
SURVIVAL RATE OF PATIENTS WITH OSTEOGENIC SARCOMA

Form of Therapy	No. of Cases	5 years	3 years	1 year
Amputation and irradiation	3	1	2	0
Excision and irradiation	14	4	4	6
Irradiation alone	31	1	0	30
Total	48	6	6	36

over the original lesion. At this time a chest roentgenogram revealed extensively disseminated metastatic nodules throughout both lungs. Therapy was instituted over the chest, but was of no avail. The patient died on May 20, 1941, more than eleven years after the onset of her first symptoms.

CHONDROSARCOMA

Chondrosarcoma is a malignant bone tumor, the predominating tissue of which is cartilage. There are two types, primary and secondary chondrosarcoma. The former arises in the periosteum without apparent antecedent tumor. The latter arises in a previously existing chondroma or osteochondroma.

Primary chondrosarcoma or chondromyxosarcoma is a highly malignant tumor which arises in the periosteum at the site of a tendon insertion, most frequently about the knee. The usual history is one of gradually increasing pain and swelling in a patient over twenty years of age for a period of five or six months. Roentgen examination shows little evidence of bone destruction early in the course of the disease, only a faintly visible subperiosteal shadow being present. It is one of the most malignant of the bone tumors, and even with irradiation and amputation the average patient dies of metastases within a year after treatment is instituted.

Secondary chondrosarcoma arises in a previously existing chondroma, osteochondroma, or Paget's disease in a patient over thirty years of age. Usually there is a history of a long standing asymptomatic tumor which suddenly enlarges and becomes painful. Trauma is often an antecedent factor.

The roentgen picture is characteristic, having a mottled appearance resulting from a large cartilaginous tumor containing areas of ossification. The margins are indistinct and blend with the soft tissues. The antecedent benign tumor can be detected within the mass. Late in the course of the disease the cortex and medulla of the bone may be involved.

Treatment in these cases is like that of an

osteogenic sarcoma: intensive irradiation, followed by amputation wherever possible. Where amputation cannot be done, excision and irradiation are advisable.

There were 8 cases of secondary osteochondrosarcoma in our series. Three were between twenty and thirty, 3 between thirty and forty, and 2 over forty. Three of these 8 cases survived more than five years. One of these 3, and the other 5, died of pulmonary metastases. The results are recorded in Table IV.

TABLE IV
SURVIVAL RECORD OF PATIENTS WITH
CHONDROSARCOMA

Type of Treatment	No. of Cases	5 years	3 years	1 year
Amputation and irradiation	3	2	0	1
Excision and irradiation	3	1	0	2
Irradiation alone	2	0	0	2
Total	8	3	0	5

The following is an example of a patient who survived seven years under treatment consisting of the combination of excision and irradiation.

CASE II. W. C., a white male, aged twenty-seven, was admitted on October 10, 1931, complaining of a painful tumor of the right thigh. In October, 1929, he had fallen 6 feet, landing upon and injuring the area which was now painful. He was sore for a day or two, and then the pain subsided. Two weeks later the area again became painful, and he noticed a mass which appeared to be increasing in size. At the time of admission, a hard, nontender mass about 15 cm. in diameter was noted in the upper portion of the right thigh, extending medially into the buttock. Flexion of the thigh was limited. Laboratory findings were negative. Roentgen examination revealed a large osteocartilaginous tumor extending medially and posteriorly from the neck of the right femur (Fig. 2). On October 29, 1931, excision was attempted, but could not be done completely. Pathological diagnosis at that time was osteochondroma.

Within one year there was evidence of recurrence and extension. Deep roentgen therapy

was given. The patient did well until January, 1937, when he returned with a large tumor mass in the thigh and gluteal region. A roentgenogram showed extensive recurrence, with a loss of the previously present line of demarcation of the tumor and destruction of the head of the femur (Fig. 3). Surgery was attempted, but excision could not be completed. The pathology was reported as osteochondrosarcoma. Additional radiation therapy gave little relief, and the patient died two months later.

EWING'S TUMOR

Ewing's tumor comprises a group of highly malignant endothelial sarcomas which arise in the shafts of long bones in patients during the first two decades of life. The tibia and femur are most frequently involved, but any bone of the body may be affected. The epiphysis is never primarily involved, and only rarely secondarily.

The tumor is thought to arise in the lymphatic channels of the bone. It extends longitudinally along the shaft, expanding



FIG. 2. Case II. Original roentgenogram showing osteocartilaginous tumor, the margins of which are still intact.

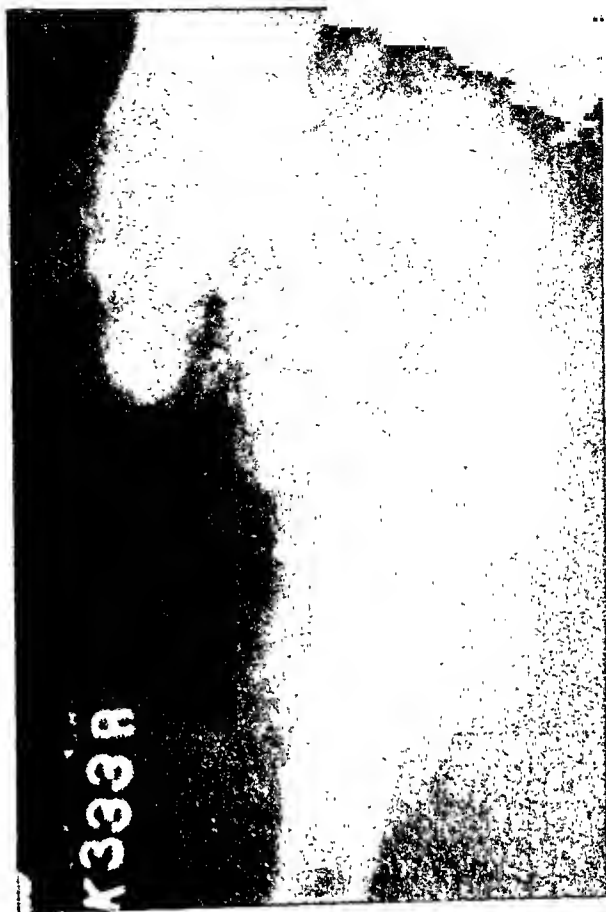


FIG. 3. Case II. Chondrosarcoma, appearance at last admission, showing extension into soft tissues and destruction of bone.

it, and later invading the medullary cavity. The tumor cells do not form bone, but reactive bone is formed subperiosteally. Microscopically, the tumor is made up of rounded or closely packed polyhedral cells, with rounded or oval nuclei and a small amount of clear cytoplasm. The history in the usual case is one of a gradually increasing painful tumor, often following trauma. The duration of symptoms may be anywhere from two months to one year before diagnosis. A generalized reaction may include fever, leukocytosis, anemia, and general debility. The roentgen picture is characteristic, consisting of fusiform widening of the shaft of the bone with successive layers of periosteal calcification extending in parallel fashion for a considerable distance along the shaft of the bone. The outermost layers end free in the soft tissues, giving an incomplete appearance. Bone destruction is absent, and

because of the periosteal ossification there is a generalized increase in density of the affected area.

Ewing's tumor metastasizes early and rapidly. The sites most frequently involved are the lungs, the regional lymph nodes, and, unlike other malignant bone tumors, the skeletal system.

TABLE V
EWING'S SARCOMA

Alive	3 yr.	1 yr.		Total
Excision and irradiation	3	5		8
Irradiation	1	3		4
Amputation and irradiation	4	6		10
Irradiation not completed			10	10
total				32

Endothelioma is the most radiosensitive of bone tumors. When there is doubt as to the diagnosis, a course of radiation therapy may be used as a therapeutic test, so rapid is the response. However, the likelihood of a permanent cure with irradiation alone is small. The treatment of choice is the combination of radiation therapy and amputation where an extremity is involved, or excision where other bones are involved. Even with the best of treatment, the prognosis is poor, since only 10 per cent or less of cases are permanently cured.

There were 32 cases of Ewing's tumor in our series. Twenty of these patients were under twenty years of age, 6 were between twenty and thirty, 3 between thirty and forty, and 3 older than forty.

Only 1 of our patients has survived and been observed for over five years. The others who were first seen more than five years ago have either died or been lost track of before the five year period was over. Several have been under observation for three years (Table v). The following case is an example of an early lesion treated with intensive radiation therapy, followed by amputation, which has survived three years.

CASE III. B. G., a white male, aged nineteen,

came to our department complaining of pain and swelling of the left elbow of three months' duration. He had been examined at an induction station and rejected because of a lesion in this area. A roentgenogram revealed irregularity and periosteal proliferation of the lower end of the shaft of the humerus (Fig. 4). A diagnosis of Ewing's sarcoma was made and confirmed by biopsy. There was no clinical or roentgen evidence of metastases. Intensive roentgen therapy was given over the elbow through several fields, and the left axilla was irradiated to skin tolerance. When this course was finished, the appearance of the bone had returned almost to normal. On April 21, 1942, a disarticulation of the left shoulder and a dissection of the left axilla were done. The patient had a stormy post-operative course, but recovered. He showed no evidence of metastases on a recent examination.

MULTIPLE MYELOMA

Multiple myeloma is an invariably fatal condition characterized by multiple simultaneous punched out areas occurring most frequently in the spine, ribs, skull, pelvis, and upper portions of the femurs. The hemapoietic tissues are affected, the histopathology being of three types—the myelocytic, the plasmacytic, and the lymphocytic myelomas.

The average age of patients with this tumor is fifty or over, with few patients under forty years of age. Clinically, the disease is characterized by generalized weakness, rheumatic pains, and skeletal deformities, including vertebral collapse, which may result in radiculites and even paraplegia. Pathological fractures occur in more than half the cases and may be the presenting feature. A nephrotic picture is present in the majority of cases characterized by Bence-Jones protein in the urine.

The roentgenologic appearance is characterized by rounded or oval punched out areas of osteoporosis with no reaction in the surrounding bone.

There is no surgical treatment that is satisfactory. Radiation therapy often gives remarkable palliative results. Pathological fractures heal more rapidly and symptomatic relief is obtained. However, the disease progresses and the patient dies

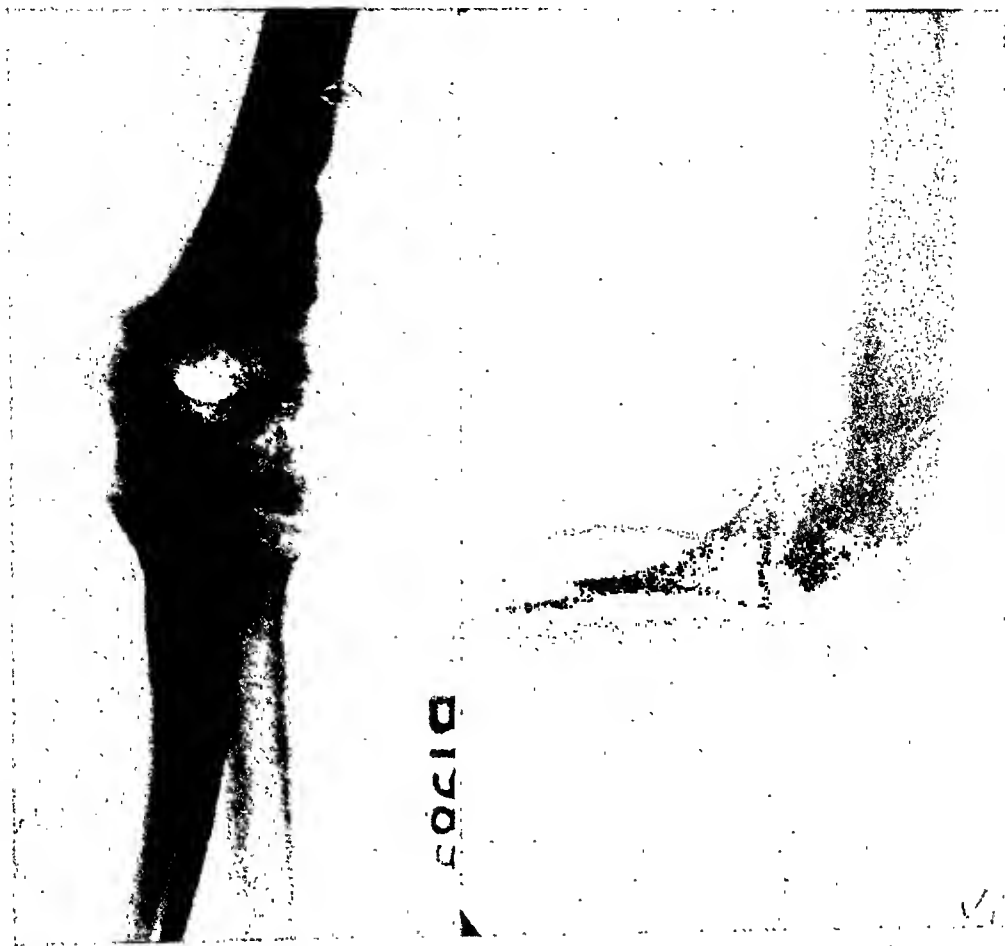


FIG. 4. Case III. Ewing's tumor, showing periosteal elevation and erosion of the cortex.

within a year or two, rarely surviving five years.

There were 18 cases in our series. Of these, 8 died in one year, 3 during the second year, and 7 lived three or more years. The following patient survived four years:

CASE IV. N. R., white male, aged forty-four, was admitted to Bellevue Hospital on December 3, 1932, complaining of pain in the chest and head, weakness, and inability to walk. Roentgen examination revealed multiple rounded expanding lesions in several ribs, the skull, and pelvis (Fig. 5). The urine was strongly positive for Bence-Jones protein. Several of the dorsal vertebrae were collapsed. Deep roentgen therapy given over the affected areas with a marked recovery of motor function and relief from pain. During the next four years he returned and was treated symptomatically. During 1936, however, he became refractory to treatment and died.

GIANT CELL SARCOMA

Giant cell sarcoma, also known by a

variety of names, including osteoclastoma, myeloid sarcoma, and solitary myeloma, has the same age and anatomical distribution as benign giant cell tumor. It occurs in the ends of long bones of young adults, involving in order of frequency the lower end



FIG. 5. Case IV. Multiple myeloma, skull showing multiple punched out areas.



FIG. 6. Giant cell sarcoma. *A*, left shows destructive lesion expanding the bone with dissolution of cortex medially. *B*, same case, six months later following radiation therapy, shows regeneration of bone.

of the radius, tibia, or femur, and the upper end of the tibia. Some appear to be malignant from the onset, while others become malignant following repeated curettage. Several authors report an average of 20 per cent of malignant tumors among giant cell tumors.

The clinical picture varies. Sometimes pathological fracture is the first indication of the condition. More often there is a history of pain and swelling in the region of a joint, frequently following trauma. It may grow rapidly and extend to a pathological fracture in from two months to a year.

The roentgen picture in the early stage is indistinguishable from that of benign giant cell tumor. One sees a cystic tumor at the epiphyseal end of a long bone or in the jaw, traversed by trabeculae with no peripheral

reaction. This expands to leave only a shell of bone which likewise subsequently is dissolved (Fig. 6*A*). There may be some periosteal reaction at the junction with the adjacent bone. Metastases occur to the lung and regional lymph nodes.

Though less radiosensitive than either Ewing's tumor or multiple myeloma, this is the tumor in which radiation therapy gives the greatest percentage of cures. There are several courses of therapy which have been followed by various workers. Good results have been reported with amputation, curettage, curettage and bone chips, excision and irradiation, or irradiation alone. Brailsford advocates the last. Our impression is that excision and irradiation is the most desirable combination. Following radiation therapy there may be

an initial extension of the tumor, but this is followed by sclerosis and often complete regeneration of bone (Fig. 6B).

There were 18 cases of giant cell sarcoma in our series. Of these, 8 failed to return following the first course of therapy. Of the remaining 10 cases, 6 had excision and radiation therapy. Four were alive and well three years later, and 2 had died during the first two years. Four patients had radiation therapy alone. Three of these were alive and well after three years, and the fourth had died of metastases.

DISCUSSION

The outlook for the patient with a malignant bone tumor is no longer hopeless. Early recognition followed by aggressive treatment with the least possible loss of time offers a good chance of permanent cure. Many patients have a long happy and useful life despite the loss of a limb incident to cure. With universal efforts toward educating the public and general practitioner to the early signs of malignant disease, it is hoped that a greater percentage of cases will be diagnosed early and cured.

The rôle of the radiation therapist is becoming more important. As a tumor specialist, he is often consulted regarding diagnosis and the courses of therapy. When diagnosis is made, he is more frequently called upon to give preoperative and post-operative radiation therapy. In the cases with metastases, irradiation offers the best hope of palliation.

SUMMARY

1. One hundred and twenty-one cases of primary malignant bone tumors seen in the Radiation Therapy Department have been reviewed.

2. A procedure in treating patients with malignant bone tumors has been outlined.

3. Each class of tumor has been treated separately.

4. Illustrative case histories of the various types of tumor are given.

5. The rôle of the radiation therapist is evaluated.

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REFERENCES

1. BRAILSFORD, J. F. Radiological evidence of malignancy in bone tumors, and its relation to biopsy. *Radiology*, 1939, 33, 476-496.
2. BRAILSFORD, J. F. Diagnosis and treatment of osteoclastoma. *Radiology*, 1944, 43, 35-38.
3. EWING, J. Review of the classification of bone tumors. *Surg., Gynec. & Obst.*, 1939, 68, 971-976.
4. EWING, J. Neoplastic Diseases. W. B. Saunders Co., Philadelphia, 1942.
5. GESCHICKTER, C. F., and COPELAND, M. M. Tumors of Bone. Revised edition. American Journal of Cancer, New York, 1936.
6. HIGINBOTHAM, N. L., and COLEY, B. L. Methods and effects of preoperative irradiation in treatment of osteogenic sarcoma. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1942, 47, 902-908.
7. LUCK, J. V. Correlation of roentgenogram and pathological changes in ossifying and chondrifying primary osteogenic neoplasms. *Radiology*, 1943, 40, 253-275.
8. HOWES, W. E., and SCHENCK, S. G. Roentgenologic considerations in diagnosis and treatment of primary malignant bone tumors. *Radiology*, 1941, 37, 18-34.
9. MEYERDING, H. W., and VALLS, J. E. Primary malignant tumors of bone. *J. Am. M. Ass.*, 1941, 117, 237-243.
10. MEYERDING, H. W. Classification of bone tumors. *Proc. Staff Meet., Mayo Clin.*, 1943, 18, 17-18.
11. MEYERDING, H. W. Comments and queries on primary benign and malignant tumors of bone. *Surg. Clin. North America*, 1943, 23, 1012-1029.
12. PACK, G. T., and LIVINGSTON, E. M., Editors. The Treatment of Cancer and Allied Diseases. Volume III. P. B. Hoeber, New York, 1940.
13. STOUT, A. P. Discussion of pathology and histogenesis of Ewing's tumor of bone marrow. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 50, 334-342.
14. SWENSON, P. C. Roentgenologic aspects of Ewing's tumor of bone marrow. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 50, 343-353.

DISCUSSION

DR. HOWARD P. DOUB, Detroit, Mich.
Dr. Rosh has presented an excellent description of what happens in a series of bone tumors as

seen in a large general hospital, especially a city hospital where all types of cases are seen.

The radiotherapist is faced with two possibilities in such cases: first, cure; second, palliation.

As to cures, we are forced to admit that our percentage of successes is going to be very low, though we find some consolation in the fact that surgery, also, has little to offer. In our choice of therapy, therefore, not only must we consider the possibility of obtaining a fair percentage of cures, but we must take into consideration any possible unfavorable effect on the patient.

As is shown in Dr. Rosh's chart, her best results were obtained by a combination of surgery and irradiation. I believe that this is true generally. Certainly it has been true in our own series.

Benign giant cell tumors, of course, call for irradiation if we can exclude malignant variants or those which will later undergo malignant change. In our series, presented a few years ago, we had one case which, following all possible diagnostic procedures, was treated as a benign giant cell tumor. Unfortunately during the course of radiation therapy, evidences of malignancy developed, and biopsy showed it to be a fibrosarcoma.

In nearly all cases of malignant variants of giant cell tumor, with metastasis, the pathology is that of osteogenic sarcoma. Ewing's sarcoma, in our experience, is sensitive to irradiation, but it may metastasize rapidly and we have had no good permanent results.

I would like to say a word about a case I reported some years ago—a tumor of the clavicle with a pathological fracture, which on biopsy was diagnosed as osteogenic sarcoma. We treated with roentgen therapy plus fever therapy and obtained an excellent result. The patient is still working and there has been no evidence of recurrence. I do not present this as a case cured by fever therapy but I believe it is an indication that such combined treatment should be considered. I have no other cases with so long a survival period.

As to the palliative effects of treatment, we have to consider first the relief of pain, which means much to the patient. The growth of the lesion may be checked and life may be prolonged. It is my opinion that patients with malignant bone tumors will live longer with radiation therapy than they will following surgery, though I cannot say that they will live with less morbidity.

DR. H. S. SHOULDERS, Nashville, Tenn. I am glad Dr. Doub told you about a case. Those of you who were at San Francisco at the meeting of the Radiological Society of North America heard a presentation of some experimental work that we have been doing over a period of years with the combined method of treatment, namely, fever and roentgen therapy.

I cannot give you the full data at the present time. I hope in the next year or two to be able to do so, but we are definitely convinced that in treatment of sarcoma there is a definite field for the combination of fever and roentgen therapy. We are sure that we are getting results far beyond any other method that we have tried. I want to bring it to you in detail at a later date.

I was the one who asked Dr. Doub about his case that came up several years ago and which he reported in the literature. Those of you who have sarcoma that you can't do anything with (the surgeon doesn't want them) please try to get a fever therapist to help you out. And don't be discouraged with one case. We have treated a number of cases and tried it once, twice or three times, and I believe you will be surprised at the results.

I am not telling you that we have cured them. We started in absolutely with the supposedly hopeless cases. So far our results are rather amazing.

DR. ROSH (closing). The question has been asked: "Reference was made to the use of Coley's serum. Is it a new preparation?" No, it isn't. Dr. Bradley Coley worked on a serum over fifty years ago at Memorial Hospital. He first published his work on Coley's toxins in 1893 and 1894. After Dr. Coley, Sr. died, his son continued work together with Dr. Norman Higinbotham at Memorial Hospital. They are still working on it and claim some results.

I merely refer to our series of cases at Bellevue Hospital. We have treated some of these patients when we were able to get the serum. It was put out commercially by Parke Davis & Company about the year 1900. On one of the surgical divisions of Bellevue Hospital where Dr. Norman Higinbotham is on the staff, he brings in the preparation from Memorial Hospital and we treat the patient with it in conjunction with radiation therapy; but, as I mentioned in the paper, I feel that there is no marked difference from the injection of Coley's serum in the final outcome of relieving or curing the patient.

RECOVERY FROM RADIATION MUTATIONS OF THE GENES

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THE effects of roentgen irradiation can be divided into somatic and genetic. Somatic effects were recognized by the early pioneers in radiology. They themselves received roentgen injuries especially of the hands and face. Some had such severe damage and pain that removal of fingers, extremities, and even eyes had to be performed. It was discovered that tissues had different sensitivity to irradiation. Short-lived cells such as lymphocytes, leukocytes, and spermatozoa are more sensitive, and muscles or mature nerve cells are more resistant. Generally, cells highly active and of more independent metabolism are more readily affected. Thus it is possible to destroy some tissues while at the same time neighboring structures receive little or no harm. In other words, there seems to be recovery of cells from minimal roentgen injury. It is important to keep this in mind.

SOMATIC EFFECTS

With the use of the roentgen ray for diagnostic purposes it is fair to assume that the amounts of energy employed are extremely safe as far as the somatic tissues are concerned. When roentgen rays were first used, single coated glass plates and gas roentgen tubes were employed. This often required long exposures which were not accurately controlled. Tissue injury could and did occur. Roentgenologic technique is improving all the time. A double coated roentgen film is now in use. Since its introduction it has been given greater and greater sensitivity thereby shortening the roentgen-ray exposure. The same can be said for the intensifying roentgen-ray screens. Today only a small fraction of the energy of the early days is required for the same roentgenologic study. What is more,

it is safe to say that this will probably be reduced to even a smaller fraction in the future.

The rapidly growing fetal cells are sensitive to roentgen exposure; 450 roentgens delivered into the uterus will usually cause fetal death in early pregnancy. In fact, this is an accepted method for inducing abortion. In order that this treatment shall not result in failures the exposures have been increased to 600 r. As a result all manner of defective structures of the fetus develop, particularly changes of the nervous system and eyes. Douglas Murphy has made an extensive study of the harmful effects of roentgen irradiation of the fetus. He emphasizes the danger of giving roentgen treatments for fibroids in the presence of a fetus in utero. This is particularly important because fibroids tend to become very large during such a time so that they may overshadow the pregnancy. Since the dosage applied under such conditions usually runs between 400 to 600 r delivered to the uterus and ovaries, the chances are that the fetus will die. However, if, let us say, 200 to 300 r is given and then the treatment is stopped because a pregnancy is discovered, it has actually happened that the mother has given birth to a live baby. Such offspring are likely to have mental and physical deficiencies.

With the roentgen-ray technique used today for diagnostic purposes during pregnancy from 1 to 2 r per film reaches the uterus. Frank Liberson (personal communication) made such measurements with the ionization chamber actually in the vagina during the exposures. By using speed developer we have been able to reduce the required energy about one-third. As a result, for a four film pregnancy study we deliver about 5 r into the uterus.

This appears to be safe within a wide margin. No recognizable change in the babies has been noted in over 4,500 pregnancy cases that we have roentgenographed in the past nine years.

GENETIC EFFECTS

Bailey and Bagg,¹ as early as 1923, reported mutational effects on mice from roentgen exposure. These first appeared in the great grandchildren. Other workers failed to confirm this work. They felt that the controls were inadequate and that the mutations could have been spontaneous.

In 1927, Muller^{5,6} reported that he was able to produce mutations in fruit flies by roentgen irradiation. Their life cycle is only ten days from egg to mature reproducing fly. They are available in almost limitless quantities. As a result, his work could be extensively done and quickly performed. He found that the mutational variations were haphazard and of the same type as occurred naturally. They were in the main harmful or lethal. Flies would occur without wings or with deformed antennae, for example. The mutations were roughly proportional to the roentgen-ray dosage applied. The natural mutational rate could be doubled with the use of 30 to 40 r. It was only natural for Muller to suspect cosmic rays as the cause of mutations under ordinary conditions. Biological effects are similar with roentgen rays, gamma rays, and neutrons. Cosmic rays are high speed, extremely penetrating rays, that reach us from outer space. They should have similar biologic potentiality. What is even more Muller was able to show that the roentgen irradiation effects in fruit flies were cumulative from generation to generation, and roughly proportional to the total applied energy. This is indeed something with which to reckon. Are we in the process of applying to the genes of each generation, roentgen effects which are cumulative and harming the human race?

Hanson, Heys and Stanton² in 1931 subjected male fruit flies to exposure to roentgen rays, all conditions being constant ex-

cept that the voltage was varied. The mutational rates were judged by a particular lethal effect which occurred in their controls and against which comparison could be made. At 76 kv., 1,500 r was delivered to the male flies giving an increase which was about 70 times the control rate. Since the mutational rate is supposedly roughly proportional to the energy applied then 5 r (as used for a roentgen examination for pregnancy) would produce in the fruit fly over 1,500 multiplied by 70 as the increase in rate. This gives an increase of less than one-fourth the controls. This would be negligible even in fruit flies.

When chromosomes are struck by roentgen radiation, cosmic rays, and for that matter neutrons, a local injury to the genes can occur. The thread-like chromosome seems to be broken at that spot, and it often happens that the ends rejoin or attach themselves to other broken chromosomes. In this manner, there may be an actual local destruction of genes and also what is known as a translocation of a series of genes.

By way of review, let us outline some of the outstanding experimental evidence:

1. Roentgen rays or gamma rays in a hit or miss fashion on striking genes produce changes which are inheritable.
2. The changes in fruit flies are roughly proportional to the applied energy, the more energy applied, the more changes.
3. The effects are cumulative, that is, if given amounts of radiation are applied to successive generations of fruit flies a summation effect is produced.
4. The mutational effects may not become visible for several generations, until there is superimposition of gene defects from the male and female chromosomes.
5. In fruit flies the mutational rate is doubled with the use of 30 to 40 r of roentgen radiation.

Henshaw,⁴ in 1941, gave a full review of this subject.

COSMIC RADIATION

If roentgen-ray effects are cumulative on

the genes, then it seems that the cosmic rays should also act in the same way. By the following calculation we have estimated that the genes should receive 0.05 r per year:

- (1) One roentgen = 2.1×10^9 ionization pairs.
- (2) Cosmic rays produce about 200 counts per minute, of pairs on the Geiger-Müller apparatus.
- (3) Cosmic counts per day = $200 \times 60 \times 24$.
- (4) Cosmic roentgens per day = $\frac{200 \times 60 \times 24}{2.1 \times 10^9}$
 $= 1.37 \times 10^{-4}$.
- (5) Cosmic roentgens per year = $1.37 \times 10^{-4} \times 365 = 0.05$ r.

These figures have been checked by Miss Lillian Jacobson and Mr. Carl Braestrup, radiation physicists. Thus in a million years man would have received 50,000 cosmic roentgens to the genes. If the effects are cumulative from generation to generation this should have destroyed life. We therefore must assume that there is recovery from the effects of cosmic and therefore from smaller doses of roentgen radiation on the genes, since we know that 10,000 to 12,000 r are lethal for most living cells.

It is also important to realize that by the time the male and female human reproduce, between them they have supposedly accumulated about 3 r ($0.5 \text{ r} \times 25 \text{ yr.}$) of cosmic rays on their genes. This is comparable to the amounts used for a pregnancy roentgen examination. We therefore feel that we are safe in saying that diagnostic roentgen exposures used at this time are producing no more harmful effects on the genes of the human race than cosmic rays, assuming cumulative effect.

It is generally true that rapidly growing cells are more sensitive to roentgen radiation. It is therefore interesting to compare the amount of cosmic roentgens received in the life cycle of the fruit fly and of man with 10 r of roentgen exposure, the amount which was used to prove that cumulation occurs on the genes of the fruit fly.

- (1) Cosmic roentgens delivered daily to the earth = 1.37×10^{-4} r.

- (2) The life cycle of the fruit fly is 10 days, equal to receipt of 1.37×10^{-3} r of cosmic energy.
- (3) The ratio of a 10 r roentgen dose to cosmic-ray dose for 10 days = $\frac{10 \text{ r}}{1.37 \times 10^{-3}}$
 $= 7,299$. This is approximately 7,300 times as much roentgen radiation as cosmic energy received in the fruit fly life cycle.
- (4) Assuming that humans' average age is 25 years at reproduction, they receive 0.05×25 of cosmic roentgens during this period, or 1.25 r.
- (5) The ratio of the same 10 r of roentgen radiation to the cosmic rays for 25 years

for the human is $\frac{10}{1.25}$ or 8 times as

great, which is much less of a ratio than with fruit flies.

Living substance adjusts itself to its environment. It is therefore likely that the human genes are adjusted to receive without harm much larger doses of cosmic energy than the fruit fly.

Since the great majority of roentgen-ray induced mutations are harmful, it is likely that other forces than the cosmic rays have been the cause of beneficial mutations. Perhaps the diploid, triploid, and tetraploid effect on the chromosomes produced by chemicals such as colchicine, where larger plants are developed, is an example of beneficial mutation. Foods and minerals may have an important bearing, judging by some recent experimental work.

VITAMIN B COMPLEX AND MUTATIONS

Muller was not able to reverse the mutational effects produced by roentgen radiation. However, Gordon and Sang,² working at Aberdeen University, did succeed in preventing such changes by feeding the fruit flies niacin, giving additional evidence that the effects of irradiation on the genes can be reversed. Although this work has not been confirmed, it has received high praise from the Science Committee of the British Council. Niacin belongs to the vitamin B complex group that

participate in the formation of enzymic systems that are involved in the production of energy in living tissue. Warkany and Nelson,⁸ by means of a vitamin B deficiency diet, have produced at will malformation of litters of rats. By feeding the mother rats a diet rich in liver and yeast the litters were born without the malformation.

Some organisms produce an excess of vitamin B complex in the intestinal tract which may be useful to the host. Where there is lack of such growth the person may have a vitamin B deficiency. This together with a defective heredity, injury or infection, may induce wild growth of cells or malignancy.

SUMMARY

1. Bailey and Bagg in 1923 reported that they had produced mutational effects in mice with roentgen irradiation.

2. Muller in 1927 showed that mutations could be induced in fruit flies by roentgen irradiation.

3. This was roughly proportional to applied dosage and cumulative from generation to generation.

4. Thirty to forty roentgens approximately doubled the control mutational rate in fruit flies.

5. Muller suggested that natural mutations might be the result of cosmic radiation.

6. By mathematical calculation, we have found that 0.05 r of cosmic rays reach the earth's surface annually. In one million years this totals 50,000 r.

7. Therefore if radiation effect is cumulative on the genes from generation to generation life should have been destroyed long ago.

8. Therefore, we are forced to conclude that there must be a recovery of the genes from radiation effects.

9. Gordon and Sang have prevented with niacin fruit fly mutations induced with roentgen radiation. This is practical proof

that the genes can recover from such injury.

10. Warkany and Nelson have produced malformation in rats by means of vitamin B deficiency.

11. It is suggested that natural beneficial mutations probably have a different cause than radiation, as for example, the triploid effect produced by colchicine.

12. A diagnostic roentgen-ray exposure compares favorably with the amount of cosmic energy the body receives in a lifetime. Since it has been shown that recovery from such small doses occurs, then we can safely say that such degrees of exposure will not harm the coming generations of men.

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REFERENCES

1. BAILEY, H. C., and BAGG, H. J. Effects of irradiation on fetal development. *Am. J. Obst. & Gynec.*, 1923, 5, 461.
2. GORDON, C. C., and SANG, J. H. Niacin Prevents X-Ray Mutations in Fruit-Flies. Quoted from cablegram to W. Kaemphfert, *New York Times*, Sept., 1943.
3. HANSON, F. B., HEYS, F., and STANTON, E. Effect of increasing x-ray voltages on the production of lethal mutations in *Drosophila melanogaster*. *Am. Naturalist*, 1931, 65, 134.
4. HENSHAW, P. S. Biological significance of tolerance dose in x-ray and radium protection. *J. Nat. Cancer Inst.*, 1941, 1, 789-805.
5. MULLER, H. J. Gene as basis of life. *Proc. Internat. Cong. Plant Sc.*, 1929, 1, 897.
6. MULLER, H. J. First cytological demonstration of translocation in *Drosophila*. *Am. Naturalist*, 1929, 63, 481.
7. MURPHY, D. P. Outcome of 625 pregnancies in women subjected to pelvic radium and roentgen irradiation. *Am. J. Obst. & Gynec.*, 1929, 18, 179-187.
8. WARKANY, J., and NELSON, R. C. Experimental production of congenital skeletal abnormalities in the offspring of rats fed a deficiency diet. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1942, 47, 889-893.

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E D I T O R I A L S

THE MEDICAL USE OF RADIOACTIVE IODINE

THE first radioactive iodine isotope was produced in 1935 by Fermi and his co-workers¹ who bombarded iodine with slow neutrons. This isotope had a half-life of twenty-five minutes and was later definitely identified as I^{128} . In 1938 Tope and Cork² after irradiating iodine with fast neutrons discovered a second isotope having a half-life of thirteen days. This isotope was identified as I^{126} . In the same year Livingood and Seaborg³ described three additional isotopes, I^{124} , I^{129} or I^{131} and I^{130} , having a half-life of four days, eight days and 12.6 hours respectively. These investigators studied various reactions involved in the production of radioactive iodine isotopes by bombarding, in the Berkeley cyclotron, iodine, tellurium and antimony with 8 mev. deuterons, 16 mev. helium ions and neutrons. Shortly thereafter Abelson⁴ isolated an isotope with a half-life of 2.5 hours which was a product of the fission of the uranium nucleus by neutrons. In a further analysis Abelson showed that the isotopes with half-lives of fifty-four minutes, twelve hours and eight days are also formed during the disintegration of uranium. They all are descended from active tellurium. Dobson and Fowler⁵ conducted investigations along similar lines on uranium and thorium. They found still another isotope of 6.6 hour half-life, for which no tellurium parent could be demonstrated. It was thought that this was a direct fission product of the uranium or perhaps the descendant of a very short lived tellurium.

In view of the great complexity of the dis-

integration especially in the heavier atoms it is often very difficult to determine the exact radioactive nature of the decay products and their proportional amounts. Livingood and Seaborg³ determined that the cyclotron-produced iodine isotopes emit beta rays of an energy of 1.2 to 2.1 mev. and gamma rays of an energy of 0.4 to 0.6 mev. with the single exception of I^{124} which yields positrons. By far the greater part of the radioactivity is due to the beta rays, the gamma-ray emission being very weak.

The most common method of producing radioactive iodine for medical purposes at present is to bombard in the cyclotron metallic tellurium with deuterons.* In this procedure the most important products are I^{130} of 12.6 hour half-life and I^{131} of eight day half-life. By varying the length of bombardment their ratio can be changed within certain limits. After a short bombardment the radioactivity due to I^{130} is about ten times that of I^{131} ; then this ratio decreases with prolongation of the time of the bombardment. The other isotopes are formed in comparatively small amounts. For long range tracer studies the eight day I^{131} is used permitting observation over a period of several weeks or months, whereas for internal therapy the 12.6 hour I^{130} is preferred. After a bombardment of from three to ten hours the tellurium is removed from the target and the radioactive iodine separated by a chemical process. The final solution consists of distilled water and the radioactive iodine isotopes. Sufficient inert iodine in the form of sodium iodide is added to bring the total iodine content to a certain concentration. This solution is calibrated in millicuries and administered to the subject by mouth. In case of therapy the administration is made within one to four hours after the conclusion of the bombardment to prevent too much decay of the 12.6 hour iodine.

In the initial biologic investigations under-

¹ Amaldi, E., d'Agostino, O., Fermi, E., Pontecorvo, B., Rasetti, F., and Segrè, E. *Proc. Roy. Soc.*, 1935, A 149, 522.

² Tope, G. F., and Cork, J. M. Induced radioactivity in tellurium. *Phys. Rev.*, 1938, 53, 676-677.

³ Livingood, J. J., and Seaborg, G. T. Radioactive isotopes of iodine. *Phys. Rev.*, 1938, 54, 775-782.

⁴ Abelson, Philip. Cleavage of uranium nucleus. *Phys. Rev.*, 1939, 55, 418; also, Abelson, Philip. An investigation of the products of the disintegration of uranium by neutrons. *Phys. Rev.*, 1939, 56, 1-9.

⁵ Dobson, R. W., and Fowler, R. D. Radioactive halogens produced by the neutron bombardment of uranium and thorium. *Phys. Rev.*, 1939, 55, 880; also, Dobson, R. W., and Fowler, R. D. Products of uranium fission; radioactive isotopes of iodine and xenon. *Phys. Rev.*, 1940, 57, 966-971.

* The U. S. Government has just released the iodine isotopes produced in the fission of uranium.

taken by Hertz, Roberts and Evans⁶ the only radioactive isotope available was I^{125} of twenty-five minutes half-life. This proved a great disadvantage since extensive tracer studies had to be conducted first and the period of observation was limited to about forty minutes. With the discovery of the isotopes of longer life the progress became more rapid. In 1941, Hertz⁷ was able to give a report on a series of cooperative experiments which were carried out on various phases of thyroid function in relation to the radioactive iodine. Already the earlier experiments with the twenty-six minute I^{125} isotope demonstrated that the thyroid gland collects iodine at an extremely rapid rate, as a rule within ten minutes following intravenous injection, and that previous iodization decreases this collection. It is of particular importance that both the normal and hyperplastic thyroid take up a larger portion of a small dose than of a large dose of iodine. The later experiments with the isotopes of longer life and by making use of the multiple labelling showed that in Graves' disease the collection from a second dose of iodine is almost invariably less than from the first dose, and that the best measure of the amount of collection is the size of the thyroid, a fact which has great bearing in determining the dose to be administered. Still later experiments with an externally placed Geiger counter revealed that in non-iodized Graves' disease the initial iodine collection of the thyroid gland approximates 100 per cent for small doses (0.2 to 5.0 mg.) while in the normal, in previously iodized Graves' disease, and in large doses it is considerably smaller.

The selective accumulation of the radioactive iodine in the thyroid gland was also studied by Hamilton and Soley.⁸ They chose patients with normal thyroid, hyperthyroidism, non-toxic goiter and hypothyroidism and measured the radioactivity by placing the Geiger counter directly against the isthmus of the thyroid. In order to obtain long range observations the

eight day I^{131} isotope was used and the readings repeated at varying intervals for a period of from five days to four weeks. As in the experiments of Hertz and his co-workers, a marked avidity for the iodine was noted in hyperthyroidism and non-toxic goiter whereas in the normal and especially in hypothyroidism the collection of iodine was less. An interesting observation was that in hyperthyroidism the quantity of iodine dropped to from one-half to four-fifths of the original value within a few hours after it was taken up, indicating that the mechanism of iodine metabolism is also altered. In a further series of experiments, Hamilton and Soley determined the distribution of the radioactive iodine within the removed thyroid gland by means of auto-radiography. After suitable preparation microscopic sections of the thyroid tissue were placed on ordinary no screen roentgen films and held in close contact with a small press. Following the necessary exposure the sections were stained and studied under the microscope. In the normal thyroid gland there was a uniform distribution of the radioactive iodine throughout the section. In the hyperplastic thyroid tissue the colloid contained a much higher proportion of the accumulated radioactive iodine than the cells of the adjacent acini, suggesting that part of the iodine moves rapidly into the colloid while the remainder is discharged into the blood stream. In non-toxic goiter the radioactive iodine was stored predominantly in the cells and small acini which surround the larger acini. The authors also studied in this manner four cases of carcinoma of the thyroid. Surprisingly, there was a complete failure of the cancerous tissue to accumulate significant quantities of the radioactive iodine in all cases.

Impressive experiments were carried out on other phases of the thyroid gland and its metabolism by a number of investigators. The formation of thyroxine and di-iodothyrosine by the thyroid gland, the serial recording of the embryologic development of thyroid gland, the time of appearance of the ability to accumulate iodine by the fetal thyroid tissue in various animals, are a few of the problems studied.

Three salient facts have emerged from the extensive biologic studies which are important from the point of view of the therapeutic use of the radioactive iodine: (1) the thyroid tissue possesses a very marked selective avidity for the iodine which in proportion to the size of the

⁶ Hertz, S., Roberts, A., and Evans, R. D. Radioactive iodine as an indicator in the study of thyroid physiology. *Proc. Soc. Exper. Biol. & Med.*, 1938, 38, 510-513.

⁷ Hertz, S. Radioactive iodine as an indicator in thyroid physiology; observations on rabbits and on goiter patients. *Am. J. Roentgenol. & Rad. Therapy*, 1941, 46, 467-468.

⁸ Hamilton, J. G. The use of radioactive tracers in biology and medicine. *Radiology*, 1942, 39, 541-572; also Hamilton, J. G., and Soley, M. H. Studies in iodine metabolism by the use of a new radioactive isotope of iodine. *Am. J. Physiol.*, 1939, 127, 557-572; also, Studies in iodine metabolism of thyroid gland in situ by use of radio-iodine in normal subjects and in patients with various types of goiter. *Am. J. Physiol.*, 1940, 131, 135-143.

gland is from twenty to two hundred times as high as that of any other tissue in the body; (2) this avidity is greater in diffuse hyperplasia of the thyroid tissue, in case there was no previous iodization and when the iodine is given in a small dose so as not to overflow the bloodstream, and (3) the administration of radioactive isotopes of short half-lives permits in view of the massive beta irradiation a selective destruction of the active tissue of thyroid gland.

Based on these facts several authors tried the treatment of various thyroid disorders by means of radioactive iodine. Recently, Hertz and Roberts⁹ published the results in 29 cases of hyperthyroidism treated between March, 1941, and April, 1943, at the Massachusetts General Hospital. Considering that from three to five years have now elapsed since the time of treatment in all cases, this report permits a very good estimation of the value of the method over a longer period of time.

Hertz and Roberts employed a mixture of radioactive iodine isotopes, obtained by deuterium bombardment of tellurium, which was administered orally. Over 90 per cent of the activity was due to the I^{130} of 12.6 hour half-life and most of the remainder to the I^{131} of eight day half-life. The dose varied between 0.7 and 28 millicuries, depending on the clinical evaluation of the weight of the gland. In 19 cases one single dose was given and in the other 10 the treatment was repeated from two to four times at irregular intervals. No preliminary iodization was carried out in any of the cases and the total amount of radioactive iodine was kept below 2 mg. One day to several weeks later the administration of 5 mimos of saturated inert potassium iodide twice a day was started and continued for a period of from two to four months until an essentially normal basal metabolic rate had been maintained for at least several weeks. In 20 cases a complete cure was obtained, in 1 case the dose was subminimal, in 3 there was failure and in 5 subtotal thyroidectomy was performed subsequently. It is interesting that in all these latter cases the thyroidectomy was followed by hypometabolism and myxedema.

To obtain some comparison with the roentgen irradiation as practiced routinely in hyperthyroidism, Hertz and Roberts also expressed the dose of the radioactive iodine given in roent-

gens. Although admittedly such calculations are subject to an error of ± 50 per cent it was determined that a net collection of 3 millicuries of I^{130} of 12.6 hour half-life in a 30 gm. thyroid gives 1,000 r in decaying to zero, the initial rate being 55 r per hour. For I^{131} of eight day half-life the initial rate is only 3.6 r per hour and the decay so much slower that its therapeutic effectiveness is open to question. On the basis of this comparison it was possible to gradually raise the dose of the radioactive iodine administered. In 1941 it averaged 5 millicuries, in 1942 10 millicuries and in 1943 14.5 millicuries, the largest single dose being 21 millicuries.

In a second report from the same institution, Chapman and Evans¹⁰ published an additional series of 22 cases of hyperthyroidism which were treated from May, 1943, to March, 1945. In these cases radioactive iodine alone was used without subsequent iodization or any other form of therapy. The preparation of the radioactive iodine and the method of administration were the same as used by Hertz and Roberts. The average dose, however, was considerably increased, until it amounted to from 40 to 50 millicuries. This represented 0.8 millicurie per estimated gram of thyroid tissue. Fourteen patients received a single dose, 3 were given two doses and 5 were given three doses. All responded well to the treatment, but 2 still have mild hyperthyroidism and 4 developed myxedema. In these latter patients a dose of 1 millicurie per estimated gram of thyroid tissue was given which apparently is too high. Reactions resembling roentgen sickness were observed in 6 patients without leaving any ill effects.

There has been a question from the earliest days of radioactive iodine investigations as to whether or not cancerous thyroid tissue possesses a similar iodine storing capacity. Unfortunately, the number of publications in this respect is rather small. Hamilton⁸ studied 4 cases of carcinoma of the thyroid by removing the glands two days after the administration of the radioactive iodine and determining the distribution of the accumulated labelled iodine chemically and with the aid of auto-radiographs. There was no deposition of the radioactive iodine within the malignant areas of the thyroid gland in any of the cases in contrast to the normal tissue. Hamilton, therefore, drew the

⁹ Hertz, S., and Roberts, A. Radioactive iodine in the study of thyroid physiology. vii. The use of radioactive iodine therapy in hyperthyroidism. *J. Am. M. Ass.*, May 11, 1946, 131, 81-86.

¹⁰ Chapman, E. M., and Evans, R. D. The treatment of hyperthyroidism with radioactive iodine. *J. Am. M. Ass.*, May 11, 1946, 131, 86-91.

conclusion that this agent has no value in the therapy of the carcinoma of the thyroid. Later Frantz and her co-workers¹¹ reported the results of similar investigations in 3 cases of carcinoma of the thyroid with bone metastases. In 2 cases of colloid-containing metastases, one of which was of the adenoma malignum type, there was no uptake of the radioactive iodine, but in the third case a focus in the shaft of the femur consistently showed appreciable uptake of the material, although there were numerous other nonfunctioning metastases and the patient never exhibited clinical hyperthyroidism. Very recently Leiter and his co-workers¹² presented 2 additional cases of adenocarcinoma of the thyroid with functioning metastases and clinical hyperthyroidism. In 1 patient there was a complete absence of functional thyroid tissue in the neck so that the hyperthyroidism was the result of the distant metastases. These authors expressed the opinion that the internal irradiation with radioactive iodine in large enough doses might have a beneficial effect in similar cases.

In summarizing, it may be said that radioactive iodine has already proved to be of great value in tracer studies of various phases of thyroid metabolism. It also appears from the data available so far that its employment may be envisaged in the near future for the treatment of selected cases of hyperthyroidism and perhaps some types of carcinoma of the thyroid.

¹¹ Frantz, V. Kneeland, Ball, Robert P., Keston, Albert S. and Palmer, Walter W. Thyroid carcinoma with metastases, studied with radioactive iodine. *Ann. Surg.* 1944, 119, 668-689.

¹² Leiter, L., Seidlin, S. M., Marinelli, L. D., and Baumann, E. J. Adenocarcinoma of the thyroid with hyperthyroidism and functional metastases. 1. Studies with thiouracil and radio-iodine. *J. Clin. Endocrin.*, 1946, 6, 247-261.

However, a word of caution must be sounded against too much zealousness and indiscriminate use. Although all the authors state that they have seen no untoward effects on the normal tissue of the body, the fact remains that the bulk of excretion of the radioactive iodine occurs through the very vital and rather radio-sensitive renal structures at a rate of from 30 to 40 per cent during the first four days and somewhat slower thereafter. Under certain circumstances, this rate of urinary excretion may even be higher or protracted over a considerable period of time. The experiences gained in the early days of radiology with radon solutions attest to the fact that observations over a period of many years are necessary before it is known whether or not the effect of such intensive tissue irradiation can be considered entirely harmless. Another disturbing factor is the great difficulty of accurately determining the dose to be administered. Since the total amount of radioactive iodine needed depends not only on the precise estimation of the weight of the thyroid gland, a procedure which in itself requires considerable skill, but also on the proportion and degree of activity of the functioning thyroid tissue, a gross over-irradiation may easily occur in individual cases. The relatively large incidence of myxedema tends to support such a view. In the thyroidectomized cases, a complete replacement of the thyroid tissue by fibrosis without any sign of regeneration was found in the majority of instances. Obviously, further careful investigations and prolonged clinical observations with radioactive iodine are necessary.

T. LEUCUTIA





HARRY FULLER WAITE 1872-1946

DR. HARRY WAITE, one of the earliest of America's roentgen-ray pioneers, died on January 26, 1946, at his home in Hollywood, Florida. He is survived by his wife, Mrs. Laura Waite.

Dr. Waite was born in Bridgeport, Connecticut, on February 15, 1872. He was not

quite twenty-four years old when Röntgen's discovery was announced. He immediately joined forces with his father, who founded the Waite and Bartlett Company in 1879 to manufacture roentgen-ray apparatus. He received the degree of M.D. from New York University in 1897, but

most of his active life was spent in invention, design, and manufacturing. On March 23, 1920, he was granted patent No. 1,334,936, on an oil-immersed shock-proof roentgen-ray unit with the tube and transformer in one container, which was the origin of the shock-proof dental unit, among other applications. Another basic patent contributing to shock proofing was No. 1,682,730, granted August 28, 1928, on the oil-immersed valve tube.

The Waite and Bartlett Company, some of whose static machines antedating the roentgen ray are still to be found in service in physiotherapy, was taken over in 1930 by the Picker X-ray Corporation, and Dr. Waite became the president of the Waite Manufacturing Division of that firm. Freed

from business details, he applied himself to the more congenial task of designing improved apparatus, with particular reference to the three-phase principle. Early exposure to roentgen rays meanwhile had produced the late effects only too familiar to those who are cognizant of pioneer roentgen-ray history, and like so many others he underwent amputation of fingers, skin grafts on the hands, and also a malignant ulceration of the face. And like the other pioneers, he bore these ills with the courage that ever distinguished that group.

Dr. Waite was elected an honorary Fellow of the American College of Radiology on February 14, 1939.

RAMSAY SPILLMAN



SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Sept. 17-20, 1946.

AMERICAN COLLEGE OF RADIOLOGY

Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: Palace Hotel, San Francisco, Calif., June 29, 1946.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio, Annual meeting: San Francisco, Calif., July 1-5, 1946.

AMERICAN RADIUM SOCIETY

Secretary, Dr. E. H. Skinner, 1532 Professional Bldg., Kansas City, Mo. Annual meeting: Assembly Hall, Health Center, San Francisco, Calif., June 28-29, 1946.

ARKANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Palmer House, Chicago, Ill., Dec. 1-6, 1946.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

RADIOLOGICAL SECTION, LOS ANGELES CO. MED. ASSN.

Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. Roy G. Giles, Temple, Texas.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. Carroll C. Dundon, 11311 Shaker Blvd., Cleveland, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB

Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DENVER RADIOLOGICAL CLUB

Secretary, Dr. A. Page Jackson, Jr., 1612 Tremont Place, Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Dell, Jr., 333 W. Main St., S., Gainesville, Fla. Meetings in May and November.

GEORGIA RADIOLOGICAL SOCIETY

Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

RADIOLOGICAL SOCIETY OF KANSAS CITY

Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets annually second Sunday in May.

IOWA X-RAY CLUB

Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KENTUCKY RADIOLOGICAL SOCIETY

Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY

Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

LOUISIANA RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

NEBRASKA RADIOLOGICAL SOCIETY

Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Neb. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY

Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

RADIOLOGICAL SOCIETY OF NEW JERSEY

Secretary, Dr. W. H. Seward, Orange Memorial Hospital, Orange, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY

Secretary, Dr. Major Fleming, Rocky Mount, N. C.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

NORTH DAKOTA RADIOLOGICAL SOCIETY

Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo.
Meetings held by announcement.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY

Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse.
Three meetings a year. January, May, November.

OHIO RADIOLOGICAL SOCIETY

Secretary, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

ORLEANS PARISH RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC ROENTGEN SOCIETY

Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. C. L. Stewart, Jefferson Hospital. Meets first Thursday of each month, October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY

Secretary, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets 6:30 P.M. at The Ruskin on second Wednesday, each month, October to May inclusive.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Secretary Dr. A. M. Popma, 220 N. First St., Boise, Idaho. Mid-Summer Conference, August 8, 9, 10, 1946, at Shirley Savoy Hotel, Denver, Colorado.

ST. LOUIS SOCIETY OF RADIOLOGISTS

Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY

Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly on first Wednesday at dinner.

SAN FRANCISCO RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph Levitin, 516 Sutter St., San Francisco 2, Calif. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

SHREVEPORT RADIOLOGICAL CLUB

Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.

VIRGINIA RADIOLOGICAL SOCIETY

Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO

Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE ROENTGEN SOCIETY

Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

FACULTY OF RADIOLOGISTS

Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

CANADIAN ASSOCIATION OF RADIOLOGISTS

Secretary, Dr. J. W. McKay, 1620 Cedar Ave., Montreal.

SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES

Secretary, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

SOUTH AMERICA

SOCIEDAD ARGENTINA DE RADIOLOGIA

Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDAD PERUANA DE RADIOLOGIA

Secretary, Dr. Victor Giannoni, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

CONTINENTAL EUROPE

SOCIEDAD ESPAÑOLA DE RADIOLOGIA Y ELECTROLOGIA

Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

Secretary for French language, Dr. Babaiantz, Geneva.

Secretary for German language, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD:
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY

Secretaries, Drs. L. L. Holst, A. W. Ssamycin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

The Rocky Mountain Radiological Society is resuming its Mid-summer Radiological Conference, which is to be held at the Shirley Savoy Hotel, Denver, Colorado, August 8-10, 1946. The committee is arranging an excellent program. The guest speakers will be Dr. John D. Camp, Rochester, Minnesota, Dr. William E. Costolow, Los Angeles, California, Dr. Ross Golden, New York, and Dr. H. Dabney Kerr, Iowa City, Iowa. All physicians interested in radiology are invited to attend this conference.

CANCER TEACHING DAY

A Cancer Teaching Day is to be held at Saranac Laboratory, Saranac Lake, New York, on Wednesday, June 19, 1946, under the auspices of the Medical Society of Franklin County, Saranac Lake Medical Society, Medical Society of the State of New York, and the New York State Department of Health, Division of Cancer Control. The meeting will be called to order at 3 P.M., with opening remarks by Morton L. Levin, M.D., Director, Division of Cancer Control. The following papers will be presented at the afternoon and evening meetings: Cancer of the Uterus and Vagina. By Arthur J. Wallingford, M.D., Albany Medical College, Albany, N. Y.; Cancer of the Breast. By Cushman D. Haagensen, M.D., Columbia University, New York; Cancer of the Stomach. By Robert J. Booher, M.D., Memorial Hospital, New York; Lung Tumors. By John D. Stewart, M.D., University of Buffalo School of Medicine, Buffalo, New York.

NEW ENGLAND ROENTGEN RAY SOCIETY

The New England Roentgen Ray Society held its last meeting of the season on Friday, May 17, 1946, at the Harvard Club, Boston. Officers elected for the coming year

are Dr. Samuel A. Robins, *President*; Dr. Stanley A. Wilson, *Vice-President*; Dr. George Levene, *Secretary*.

The feature of the evening was the second George W. Holmes Annual Lecture which was delivered by Dr. Arthur C. Christie of Washington, D. C. Dr. Christie's subject was "The First Fifty Years of Radiology; The Elements Which Have Contributed to Its Growth as a Great Medical Specialty." Dr. Holmes and Dr. Christie were both presented with the Society's silver colonial pitcher which is emblematic of the occasion. Dr. Holmes received congratulatory telegrams from his former students from various parts of the country. The occasion was a fitting tribute to a great radiologist and teacher.

GEORGE LEVENE
Secretary

RADIOLOGICAL SOCIETY OF NEW JERSEY

At the time of the annual meeting of the Radiological Society of New Jersey held on May 22, 1946, the following officers were elected for the coming year: *President*, Dr. John Olpp, Englewood, N. J.; *Vice-President*, Dr. H. R. Brindle, Asbury Park, N. J.; *Secretary*, Dr. W. H. Seward, Orange, N. J.; *Treasurer*, Dr. R. Pomeranz, Newark, N. J.

UTAH STATE RADIOLOGICAL SOCIETY

The radiologists of the State of Utah met at a dinner meeting on May 15, 1946, and organized the Utah State Radiological Society. The following officers were elected for the ensuing year: *President*, Dr. James P. Kerby, Salt Lake City; *Secretary*, Dr. M. Lowry Allen, Salt Lake City. Meetings of the Society are to be held on the third Wednesday of the month during September, November, January, March and May.



BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

ROENTGENOGRAPHIC PATHOLOGY OF THE SKELETON. By J. Belot and F. Lepennetier. (With the collaboration of G. d'Allaines and L. Lamy.) Atlas III, Volume I. The Upper Extremity. Pp. 384, with many illustrations. Paris: Amedee Legrand and Jean Bertrand, 1944.

This is the first of three volumes of the third of a series of atlases of roentgenographic pathology of the skeleton, the two earlier atlases having been published several years before the war. In spite of the German occupation and in spite of the shortage of paper, of various other materials, and especially of skilled labor, this volume was published during the war. It deals with and illustrates non-traumatic diseases and tumors of the bones of the upper extremity.

The first section (sixty-nine pages) is devoted to lesions of the bones of the hand; the second section (forty-seven pages) deals with lesions of the bones of the wrist; the third section (thirty-eight pages), with lesions of the radius and ulna; the fourth section (forty-three pages), with lesions of the elbow joint; the fifth section (seventy pages), with lesions of the shaft of the humerus; the sixth section (thirty-four pages), with lesions of the shoulder joint; the seventh section (thirty-three pages), with lesions of the shoulder girdle (clavicle and scapula); and the eighth and last section (eight pages), with extensive lesions of an entire upper extremity, which could not well have been included in any of the other sections. The book is printed on excellent paper, and the roentgenograms are superbly reproduced. Smaller black, white and red diagrams appear alongside of each roentgenogram and help to clear up uncertain parts. Each roentgenogram is accompanied by textual explanations and pertinent comments.

Anyone who is acquainted with the authors and their work would know that they would not publish inferior work; they and the publishers deserve special credit for having succeeded in bringing out such an outstanding book despite the handicaps imposed by the war. A few conditions have not been adequately illustrated or have been omitted altogether; these include the syndrome characterized by multiple and asym-

metrical fibrocystic disease, precocious puberty, multiple areas of abnormal pigmentation of the skin, with or without hyperthyroidism, cases of which have been reported by McCune, Albright, and others. Another condition which does not appear in this atlas is the general osteoarthropathy, sometimes known as pulmonary osteoarthropathy, or Marie's disease. No doubt the first of these omissions may be attributed to the war and to the impossibility of keeping abreast of the literature during its course. As for the second omission, this may have been intentional, the authors perhaps intending to deal with this condition in another volume.

If all the volumes in this series of atlases should be as good as this one—and there is every reason to think that they will be—every library should have them.

A. U. DESJARDINS

CANCER DE LA LARINGE. ESTUDIO RADIOLOGICA. By Felix E. Leborgne, M.D., Chief of the Radiological Service of the Pereyra Rossell Hospital, Montevideo, Uruguay. Pp. 387, with 355 illustrations. Montevideo, Uruguay: Casa A. Barreiro y Ramos, 1943.

After careful perusal of this monumental work one is impressed with a sense of great admiration for the author and gratitude that he has felt impelled thus to make a permanent record of his labors in this particular field of radiology. The publisher has made an exceptionally attractive volume which is substantially bound. The nearly four hundred pages of the book consist in large part of illustrations, which include ordinary roentgenograms of exceptional quality and tomograms which are perhaps as appropriate and helpful in the study of the larynx as in any part of the body. There are numerous drawings illustrative of laryngoscopic findings and explanatory line drawings to render more sure the interpretation of the roentgenograms. Numerous photographs of anatomical specimens and photomicrographs further assist in elucidation of this subject. The entire book is devoted to cancer of the larynx, as is indicated by the title. The text is arranged

in logical consideration of the anatomical and technical considerations of the study of the larynx and hypopharynx and a classification of pharyngeal and hypopharyngeal tumors, all of which have been discussed at great length so that the work presents as complete a study of

laryngeal carcinoma and its differential diagnosis from the roentgenologic standpoint as one could possibly imagine. It is to be hoped that an English translation of this valuable treatise may become available.

JAMES T. CASE



DEPARTMENT OF TECHNIQUE

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THE USE OF TANNIC ACID IN BARIUM ENEMAS

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IN A PERSONAL communication from Lieutenant Colonel George L. Sackett, M.C., A.U.S., I learned that when making barium studies of the colon better mucosal patterns on the evacuation films could be obtained if powdered tannic acid were added. The results of the addition of one level tablespoonful of powdered tannic acid to each 2 quart barium and water mixture, prior to the administration of the enema, have been so satisfactory that it is now routine at this Army general hospital to make this addition. In no case has any

patient complained of any unpleasant after effects from the addition of tannic acid to the barium enema mixture. Unless contra-indicated, castor oil or compound licorice powder in addition to tap water enemas is used in preparing the patient.

Various patterns obtained are shown in the accompanying illustrations.

210 North Central Ave.,
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FIG. 1. Evacuation pattern—Normal.

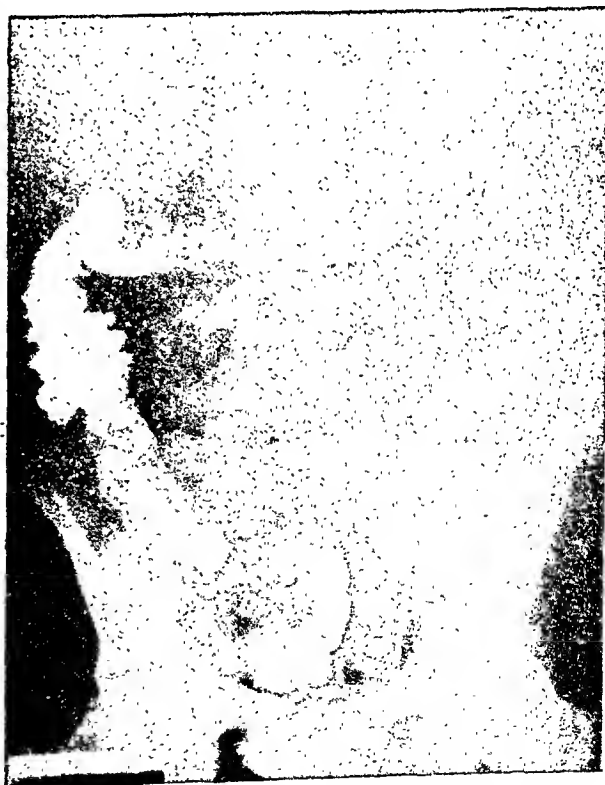


FIG. 2. Evacuation pattern—Ulcerative colitis, chronic, severe, cause undetermined. Changes can be seen throughout the mucosa, most marked in the cecum and ascending colon.



FIG. 3. Evacuation pattern—Ulcerative colitis, chronic, severe, cause undetermined. In addition to other mucosal changes, severe granular degeneration is demonstrated in one long segment of the colon

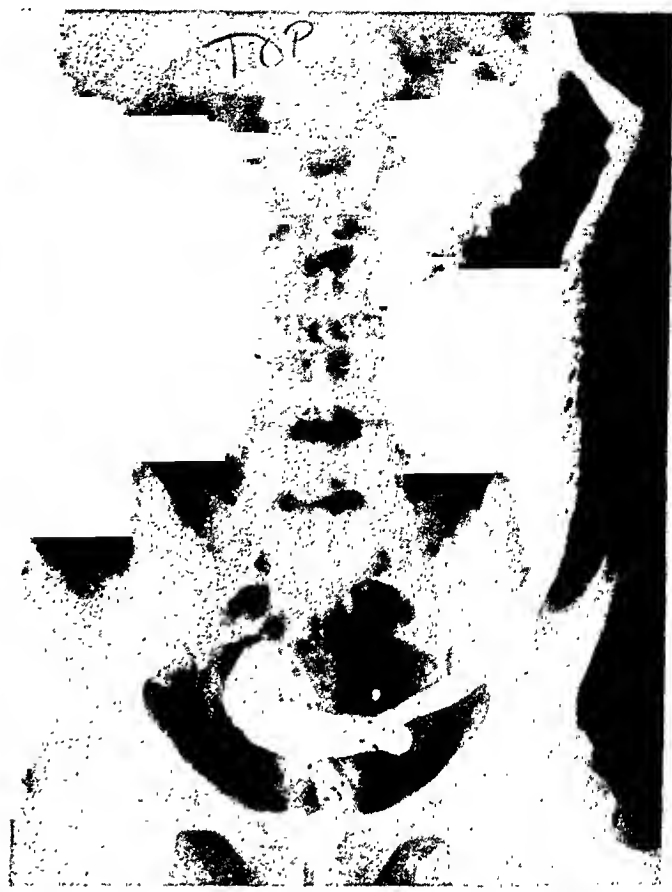


FIG. 4. Evacuation pattern—Ulcerative colitis, chronic, cause undetermined with pseudopolyposis. A Mikulicz colostomy of the transverse colon has been performed.



FIG. 5. Evacuation pattern—Congenital polyposis.



FIG. 6. Immediately following the administration of the enema—There was a constant filling defect in the proximal sigmoid colon, found at operation to be a polyp 2 cm. in diameter, and diagnosed colloid carcinoma without evidence of extension. Diverticula are also demonstrated.



FIG. 7. Same case as shown in Figure 6. Evacuation pattern—The diverticulosis is demonstrated; however, the carcinomatous polyp is not demonstrated.



FIG. 8. Same case as shown in Figures 6 and 7. Air contrast study—The polyp is well demonstrated.



THE LATERAL PROJECTION IN ROENTGENOGRAPHY OF THE STERNOCLAVICULAR ARTICULATION

By ROBERT KURZBAUER, B.Sc., R.T.

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THE roentgen examination of the sternoclavicular articulation and the projection of its shadow on the film with a minimum of distortion and confusion with the underlying structures have always confronted the roentgenologist with some difficulties.

The demonstration of this articulation is of great importance in many conditions of either traumatic or pathologic nature; thus the necessity of obtaining images of diagnostic value, even under adverse conditions has led to the development of many techniques designed to achieve this goal. Short distance exposures, off center, and oblique projections have been utilized to visualize this area in the posteroanterior aspect.^{1,2,3,4,5}

The routine lateral projection,^{2,3} due to the superimposition of both articulations



FIG. 1.

and resulting interpretative difficulty, has not been frequently employed.

A lateral projection whereby each articulation could be clearly defined would constitute not only a useful supplement to the routine posteroanterior views but prove sufficient in itself, especially in many cases where, because of trauma to the patients'

anterior chest wall, a prone position would be painful and immobilization hard to maintain.

Clark² briefly mentions the possibility of such a method. A procedure has been evolved which, by adapting the principles of the well known technique for the lateral upper dorsal spine, modifies this view to produce satisfactory roentgenograms of each articulation separately and particularly detailed images of the sternal half of the clavicle.

The patient is positioned laterally recumbent, the affected side lowermost, on the roentgenographic table, with a frontal plane through the sternoclavicular articulations coinciding with the long axis of the Potter-Bucky diaphragm. The arm nearer the film is extended fully cephalad, the hand grasping the end of the table. The uppermost arm is pulled caudad along the lateral chest wall using slight force. This maneuver will rotate the upper half of the shoulder girdle caudad in relation to the one nearer the film, resulting in an adequate separation of the shadows of both articulations on the film.

The principal ray is directed caudad at an angle of 15 degrees from its perpendicular position through the lower articulation, using a 3 inch localizing cone (Fig. 1). The center of an 8 by 10 inch cassette is aligned to coincide with the principal ray. The patient is instructed to arrest breathing on maximum inspiration.

The foregoing procedure will yield an effective separation of the otherwise superimposed articulations and present an undistorted true lateral view. The projection of the lowermost articulation above rib level into the soft tissues of the neck clears the image from all confusing thoracic densities (Fig. 2 and 3).



FIG. 2.

It is of interest to note that in this projection the trachea may be seen in its fullest extent which could be helpful in the recognition of any deviation of this structure from its normal course as seen from the lateral aspect.

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REFERENCES

1. ANDRUS, P. M. New method for radiographic exploration of mediastinum and concealed por-

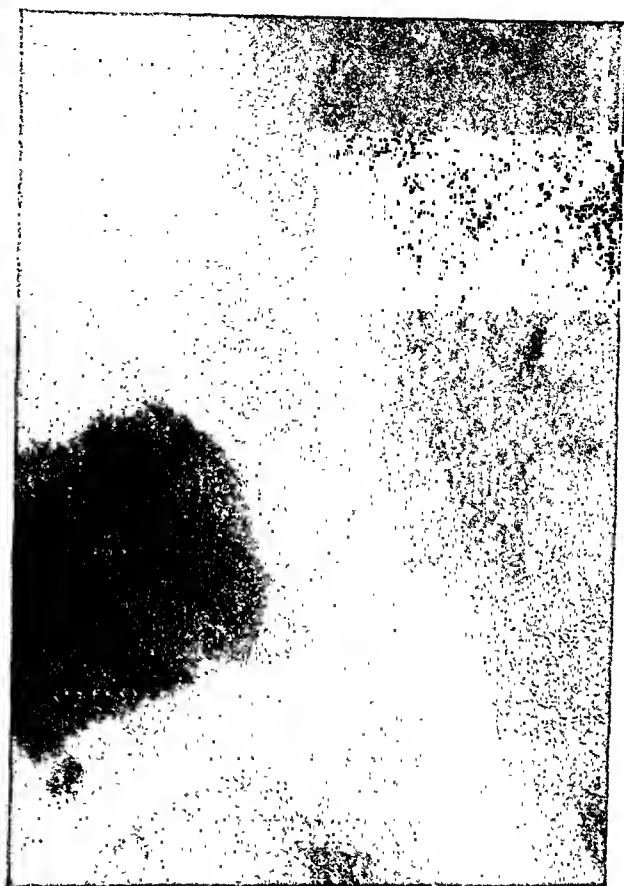


FIG. 3.

- tions of pulmonary fields. *Radiology*, 1934, 23, 97-101.
2. CLARK, K. C. Positioning in Radiography. Second edition. W. Heinemann, Ltd., London, 1941.
3. GUNSON, E. F. Radiography of sternoclavicular articulation. *Radiog. & Clin. Photog.*, 1943, 19, No. 1, 20-24.
4. JÖNSSON, G. Method of obtaining structural pictures of sternum. *Acta radiol.*, 1937, 18, 336-340.
5. SANTE, L. R. Manual of Roentgenological Technique. Ninth edition. Edwards Brothers, Inc., Ann Arbor, Mich., 1942.



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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIGNOSIS

HEAD

NEW, GORDON B., and FOSS, EDWARD L.
Tumors of the nose and the throat. *Arch. Otolaryng.*, Aug., 1944, 40, 142-149.

Bowen's "precancerous dermatosis" is still considered by some authors as a precancerous dyskeratotic process but is regarded by the majority as a highly specialized form of superficial squamous cell epithelioma with lateral intraepithelial spread. Two typical cases of Bowen's disease of the mucous membrane have been reported by Brighton and Altman. In one of these there was involvement of the anterior part of the nasal septum and in the other a vocal cord was involved. It is pointed out that histopathologically, Bowen's disease and epithelioma of the mucous membrane resembling Bowen's disease are closely related.

Blair and Byars recommend that any black melanin-containing mole be removed. They express the belief that any doubtful localized chronic change occurring on the vermilion or the mucocutaneous border of either lip should be regarded as squamous cell carcinoma until definitely proved not to be that. These workers do not excise lymph nodes of the neck routinely in all cases of cancer of the lip. They advise excision of these nodes in those cases in which it is felt that danger of metastases is present. This decision is made on the basis of the virulence of the new growth, from the degree of extension and from the history of meddlesome or irritative treatment.

In all cases of cancer of the tongue, cautery-biopsy is done by Blair and Byars, complete excision-biopsy when practical. This is usually followed by interstitial implantation of a large dose of radon. Excision of the lymph nodes of the neck should be considered in almost all cases of cancer of the tongue.

Martin and Koop believe that the most frequent and probably the most important form of chronic irritation from the standpoint of carcinogenesis in the oral mucous membranes is that due to avitaminosis B.

Tumors of the Nose and Accessory Sinuses.

Dermoid cyst of the nose (Holmes) usually starts in connection with either the nasal bones or the frontal bones, so that even if the cyst presents itself at the tip of the nose, its stalk of origin will be found to extend to, and be in contact with, either the nasal bones or the frontal bone.

McGillicuddy believes that intranasal encephalomeningocele is probably diagnosed occasionally as nasal polyps or as fibroma. He suggests that in some cases in which meningitis and death have followed the removal of what seemed to be an innocent polyp the tumor may well have been an encephalomeningocele.

Davis presents a case of nasal fibroglioma heterotopia. He concludes that tumors of this type belong to a group of congenital benign fibrogliomatous tumors which originate embryologically from encephaloceles.

Tumors of the Lips and Mouth. Johnston lists the cysts usually found in the floor of the mouth as dermoid, epidermoid, ranular, thyroglossal, mucous and branchial. Any cyst in this site, regardless of its origin, has to be removed surgically.

Two cases of generalized neurofibromatosis in which there was bulky invasion of the oral cavity are reported by Martin and Graves. Both patients were children and one of the oral tumors took on malignant, locally invasive characteristics and caused death.

Schreiner and Christy review 636 consecutive cases in which cancer of the lip was treated by irradiation. Of 27 patients who had lesions that were proved to be metastatic and were treated by implantation of radon seeds and radium needles and by irradiation with high voltage roentgen rays, only 2 (7.4 per cent) remained well five years or longer.

In the discussion of treatment of cancer of the mouth Scarborough states that irradiation is the method of choice in the treatment of the primary lesion. Excepted are pedunculated tumors occurring on the lip, buccal mucosa and anterior third of the tongue, as well as adenocarcinoma occurring on the roof of the mouth. These should be excised by cautery after pre-operative irradiation.

Wilson states that the eradication of the primary lesion of carcinoma of the lip may be accomplished in most cases by either surgical means or irradiation. A block dissection of the regional lymph nodes increases the likelihood of a permanent cure.

Tumors of the Nasopharynx. Lenz has reviewed 63 cases of cancer of the nasopharynx and he concludes that, at present, roentgen therapy is the treatment of choice in these cases. Roentgen therapy at 200 kv. can control the cancer for five years or longer in about a fourth of all cases.

Eighty-five per cent of the nasopharyngeal tumors encountered in practice fall into the group of undifferentiated epithelioma, lympho-epithelioma, lymphosarcoma and plasmocytoma. Martin believes that irradiation is the treatment of choice in dealing with these tumors.

Tumors of the Oropharynx and Hypopharynx. The Schmincke tumor is defined as a malignant neoplasm of lymphoid tissue usually found in the pharyngeal region. This tumor is characterized by a peculiar admixture of lymphoid cell intimately associated with epithelial elements of an immature squamous or epidermoid type. There is a tendency to early and rapid metastasis. This tumor is, however, extremely radiosensitive.

Tumors of the Larynx. The anatomy of the anterior commissure tendon is discussed by Broyles. He concludes that in all probability early recurrence in cases of carcinoma of the anterior portion of the larynx should be considered continuation rather than recurrence and that carcinomatous growth was retained in the tendon or in its insertion into the thyroid cartilage.

Medical interest in histoplasmosis has been aroused recently by the increased number of reports published. A case is reported in which there was laryngeal histoplasmosis. The patient was a male, sixty-three years of age, a small polypoid tumor was seen on the left vocal cord, from which the diagnosis was made (microscopically). Another case of laryngeal histoplasmosis is reported in which the larynx appeared white and nodular.

Laryngeal tuberculosis is always secondary to a pulmonary focus. Donnelly, in a review of 1,800 tuberculous patients found that in 26 cases laryngeal symptoms developed before any systemic signs.

Roentgen examination of a patient who has

explained laryngeal symptoms may disclose early chondroma. Chondroma may exist undetected for years in the subglottic region of the larynx. (The most useful information which can be obtained by roentgenologic examination of the larynx is obtained by a laminagram.)

Iglauer presents a case of myoblastoma of the larynx. (Eight such cases have already been reported.) On mirror examination a large pedunculated tumor was seen in the posterior portion of the larynx between the arytenoid cartilages.

LaJeune and Bayon point out that the ideal case of laryngeal carcinoma, from an operative standpoint, is one in which the lesion involves the middle portion of a vocal cord with both ends uninvolved.

Tumors of the Trachea. A case of tracheal ectasia occurring in a white adult male is reported. (Synonyms include tracheal hernia, tracheocele, tracheal diverticulum, aerial goiter, arocele and bronchocele.)

Tumors of the Esophagus. Twenty-five cases of grossly pedunculated benign tumors of the esophagus are reviewed.

Carcinoma of the esophagus is a highly malignant disease. The tumor remains localized until very late and metastasis to distant organs is found in less than 40 per cent of the cases. Watson finds that carcinoma of the upper part of the esophagus is curable by irradiation. Smither, Clarkson, and Strong believe that roentgen therapy has much to recommend it in the treatment of carcinoma of the esophagus for it is the most effective method of securing palliation and at the same time causes the patient least discomfort.—*Mary Frances Vastine.*

FLETCHER, RUSSELL, Sarcoid of the nose. *Arch. Otolaryng.*, June, 1944, 39, 470-473.

Sarcoid is so similar to tuberculosis in so many of its manifestations that many authorities believe that they are the same disease, although it has sufficient variations from typical tuberculosis to cause other authorities to disagree. Boeck, in 1899, was the first to use the term "sarcoid." Typically, Boeck's sarcoid included involvement of the skin, the mucous membranes and the lymph nodes. Gradually new regions were found involved and given the name of the observer, such as Jungling's disease, involving the bones, or Mikulicz' syndrome, involving the lacrimal and salivary glands.

Histopathology of Sarcoid. The unit of the

microscopic picture is the epithelioid tubercle without caseation. It consists of large pale-staining polygonal epithelioid cells forming a mass about the size of a miliary tubercle.

Differential from Tuberculosis. (1) The tubercles in sarcoid remain stable and unchanged for long periods of time and do not usually tend to break down, ulcerate or caseate. (2) Multiple lesions in various parts of the body are commonly found in sarcoid. However, none of the 4 patients having sarcoid of the nose reported in this paper had lesions in parts of the body other than the chest. (3) Most persons with sarcoid have negative reactions to tuberculin.

Treatment of Sarcoid. No treatment has been found to be effective. In 2 of the cases reported by the author, the nasal lesion was excised surgically and did not recur.

Conclusion. Four cases of nasal sarcoid are reported. The diagnosis in each case was proved biopsy. Undoubtedly, many such cases are overlooked.—*Mary Frances Vastine.*

SCHUGT, HENRY P. Pain referred to the face, neck, upper extremity and chest due to lesions in the ear; report of two cases. *Arch. Otolaryng.*, May, 1944, 39, 430-431.

Pain due to pathologic conditions in the ear simultaneously involving such large areas as the face, the neck, the arm and the chest is an uncommon occurrence. The 2 patients described in this article were treated for chronic mastoiditis. The author gives an explanation of the neurologic pathways according to present knowledge: Afferent branches of the upper thoracic nerves extend along the carotid arteries and afferent fibers of vagus origin join the plexuses on the internal and external carotid arteries and reach the area of the trigeminal nerve. Afferent impulses therefore arising in primary lesions such as those in the mastoid area are conducted from the site of the lesion into the spinal cord through afferent components of the thoracic nerves, which traverse the nerves associated with the common internal and external carotid arteries. The autonomic components of referred pains localized in the lower cervical and upper thoracic segments and the upper extremity which are due to lesions in the mastoid area can thus be explained. Werne's experimental work showed that the referred pain associated with visceral lesions has its origin in changes in the skin and the underlying tissues through viscerocutaneous reflexes; in other words, the sensation of

pain is the direct result of afferent impulses which arise in the periphery.—*Mary Frances Vastine.*

GOUGH, C. W. C. Tomography of the temporomandibular joint and ramus of the mandible. *Brit. J. Radiol.*, July, 1944, 17, 213-215.

In standard views of the temporomandibular joint there is usually distortion of the neck and ramus of the mandible. An undistorted view is absolutely essential to plastic repair and such views can be obtained by tomography. The technique is simple and it does not take any longer time than the standard views. The patient's head is placed in the true lateral position and a section at a depth of 1 inch is satisfactory. Good results can be obtained with a homemade tomograph attachment, an exposure of 65 kv., 30 ma. and $3\frac{1}{2}$ seconds exposure time (four-valve unit) at a distance of 40 inches using a Potter-Bucky diaphragm.

Tomography is also useful in some other conditions to demonstrate lesions that are not clearly shown by routine roentgenography. Among these are congenital facial asymmetry, fibrous and bony ankylosis of the temporomandibular joints, external fixation of a fractured mandible and gunshot wounds of the mandible. Illustrative cases are described and illustrated with tomograms.—*Audrey G. Morgan.*

ROSS, JOHN A. Some observations on dental changes in possible riboflavin deficiency. *Brit. J. Radiol.*, Aug., 1944, 17, 247.

Some cases of dental deficiency in a group of young men from a native camp in the Middle East are reported. They showed loose incisor teeth but without any gum infection, which is unusual. Roentgenograms of two typical cases are given. Except for osteoporosis at the margin of the alveoli the rest of the bone showed good density and none of the other bones were affected. The author thinks it possible that this condition may be caused by a deficiency of riboflavin in the diet. The blood calcium of the patients was slightly low.—*Audrey G. Morgan.*

NECK AND CHEST

WELDMAN, WILLIAM H., and KEIFFER, JEAN. Control, duplication and standardization of radiographic chest technique. *Am. Rev. Tuberc.*, March, 1944, 49, 203-226.

While variations equivalent to 5 kilovolts on

either side of the density generally considered optimum do not affect the value of a chest roentgenogram considered singly, film pairs more than 4 kv. equivalent apart are not satisfactory. Frequently such films lead to disagreement among various interpreters concerning the progress of a pulmonary lesion or conclusions are reached which are not substantiated by the patient's clinical course.

A review of serial roentgenograms in an average laboratory demonstrated variations equivalent to 5 kv. or more at least 50 per cent of the time; moreover, variations equivalent to 4 kv. in stereoscopic pairs were common.

Prior to the inauguration of accurate technique control 35 per cent of the authors' serial films were within a ± 2 kv. (peak) comparison tolerance. In order to study the underlying factors producing this technique discrepancy, a thin, copper step tablet surrounded by a lead mask was constructed. This small device could be mounted directly on a cassette, and variations in tablet image densities produced on different roentgenograms by a supposedly similar technique could be compared—density differences on two films taken by the same technique thus indicating total technique variations. In addition, a set of standards consisting of tablet images taken at 2 kv. intervals and covering the entire range of routine techniques was prepared. Comparison of a tablet's image on a selected roentgenogram with the standard permitted estimation to within 1 kv. of the kv. (peak) which should have been used to obtain the desired results if all other factors of exposure, material, and processing remain constant. Review of a year's work (7,000 films) following institution of rigid total technique control measures based on routine utilization of the copper step tablet showed 93 per cent of their roentgenograms within limits of ± 2 kv. (peak) from expected results.

Included in the paper is a description of the step tablet, an account of its practical uses and a helpful analysis of common processing variables and errors—the key to great improvement in serial film technique duplication.—*John R. Hamman.*

COLE, WARREN H. Classification of chronic cystic mastitis. Editorial. *Surg., Gynec. & Obst.*, July, 1944, 79, 109-112.

Practically all writers agree that cancer may and does develop in areas of chronic cystic mastitis even though there is as yet no means of

determining just how often and in what types of chronic cystic mastitis this may occur. A study of numerous specimens of chronic cystic mastitis reveals five or six major histopathologic features.

1. Fibrosis is encountered in practically all specimens.

2. Hyperplasia of the glandular elements is the next most common change observed. This hyperplasia may affect the glands themselves or the ducts.

3. Not infrequently the hyperplasia develops with changes which are of a precancerous nature, i.e., there is much variation in size and shape of the cells.

4. There may be a variable degree of dilatation of the ducts or glands, particularly the former.

5. Sometimes these cyst-like spaces may attain a size several centimeters in diameter (when they are designated as cysts).

6. Lymphocytic infiltration is noted to a variable degree but no significance can be ascribed to this change.

When the pathologic changes above described are correlated with the clinical findings, the following four distinct classifications may be identified:

1. Adenofibrosis. In this lesion the predominant change is fibrosis. Glandular elements are present in decreased numbers. Grossly the breast is firm but resilient; the glandular elements are so sparse that the cut surface is fairly homogeneous and presents an ivory white surface. Tenderness and pain are slight. Adenofibrosis was encountered in 22 per cent of the author's cases. The average age was 37.4 years.

2. Benign parenchymatous hyperplasia. The predominant microscopic feature of this lesion is a proliferation of the ducts, glands and connective tissue stroma, particularly the ducts. Palpation of the breast reveals numerous nodules, varying from 5 to 15 mm. in diameter. On cut section the larger ones contain material which may vary in color and consistency from thin amber colored fluid to thick, yellow brown, pasty material. In the series, 46 per cent of the cases were classified in this group. The average age of the patients was 43.7 years.

3. Precancerous hyperplasia. The hyperplasia in this group resembles that seen in cancer. Even though cellular activity is pronounced, nowhere is there evidence of invasion or of the breaking through of normal barriers.

Palpation of these breasts will reveal no characteristics different from those described under benign parenchymatous hyperplasia. Of the entire series 22 per cent of the cases were classified in this group; the average age was 41.6 years.

4. Cystic disease. In this type of lesion the cystic spaces may attain a size equal to 4 to 6 cm. in diameter; they may occur singly but are usually multiple. In this group are classified the blue-domed cysts of Bloodgood. The cysts are usually palpated as firm, smooth tumors but occasionally are mildly fluctuant. Ten per cent of the series were classified in this group; the average age was 46.6 years.

Conclusions.

1. Since adenofibrosis and cystic disease rarely develop into cancer, operation need not be advised in these lesions unless symptoms are significant.

2. Since it is impossible to distinguish benign parenchymatous hyperplasia from precancerous hyperplasia clinically, and since either may become malignant, excision will be advisable in these lesions.—*Mary Frances Vastine.*

CRAWFORD, J. H. Tomographic appearance of the azygos lobe, with a description of two cases and a report of seven cases. *Brit. J. Radiol.*, Oct., 1944, 17, 319-322.

The anatomy and embryology of the azygos lobe are described. Tomography is important in detecting it and descriptions of 2 cases in young men are given and illustrated with tomograms. There is a thin curved line convex outwards over the right upper field, usually ending in a dense comma-shaped or pea-shaped shadow at about the level of the second costal cartilage. The line represents the azygos fissure and the terminal opacity the azygos vein seen end-on. The image resembles that of a spermatozoon or tadpole lying mostly below the clavicle.

At Preston Hall where the author works 7 cases of this anomaly were found among 6,000 cases examined, or in 0.11 per cent. Heredity is thought to play a part in its causation. Underwood and Tattersall made roentgen examinations of 10 relatives of 2 of their patients and the anomaly was found in 1 relative in each case. They conclude from this that heredity does play a part in its causation. In 5 of the author's cases half of the relatives were examined and no examples found, but as only half the relatives were examined the negative evidence is not conclusive.—*Audrey G. Morgan.*

FERGUSON, GEORGE B. Hemangioma of the adult and of the infant larynx. *Arch. Otolaryng.*, Sept., 1944, 40, 189-195.

The first report of a case of hemangioma of the larynx was made by Mackenzie in 1864. To date, 123 cases of hemangioma of the larynx have been recorded in the available literature. The author reports 2 additional cases. Two distinct classes have been described: (1) the adult and (2) the infantile.

Classification. The infantile type of hemangioma of the larynx is the rarer. It is located below the vocal cords. The more common type, occurring in adults, is located on or above the vocal cords.

Etiologic Factors. Over 90 per cent of the patients have been adults, and two-thirds have been males. In some cases the condition has undoubtedly been congenital and was made manifest shortly after birth. A few observers have suggested as possible etiologic factors severe cough traumatizing the vocal cords, faulty or excessive use of the voice and acute infections.

Pathologic Types. Two main types have been described—the cavernous and the simple. The tumor is designated as cavernous angioma when its vascular channels are widely dilated and the connective tissue septa thin; it is called simple angioma when composed of many small blood vessels.

Diagnosis. Quite different sets of symptoms characterize the infantile and the adult form of hemangioma:

1. Because of the subglottic position of the infantile form, a slight infection of the upper respiratory tract is often sufficient to cause symptoms of respiratory distress. Wheezing and labored respiration, quite similar to what is seen in streptococcic laryngitis, are present. However, the signs of acute infection are not so prominent.

Direct laryngoscopic examination of a young infant with severe dyspnea may be difficult, and a subglottic tumor lying diffusely under the mucous membrane may not be seen readily. Probably no attempt should be made to obtain a biopsy in such cases because of the danger of hemorrhage. The absence of inflammatory swelling and of a diphtheritic membrane is a valuable negative sign.

Lateral roentgenograms of the larynx may show a discrete tumor in the subglottic larynx.

2. In cases of the adult type of hemangioma the symptoms are often vague and of extremely

long duration. Hoarseness, followed by cough, dyspnea, hemoptysis and dysphagia are the most common complaints.

The tumor as seen through a laryngeal mirror is usually described as resembling a raspberry, irregular in surface and purplish in color. The tumor has been seen to spring from a vocal cord, a ventricular band, an aryteno-epiglottic fold, an arytenoid and the epiglottis. The diagnostic importance of the "phonation sign of Monzel" has been stressed. This consists of increased firmness, erection, diminution in size and deepening of hue of the tumor during phonation.—*Mary Frances Vastine*.

GOORWITCH, JOSEPH. Mass chest roentgenography and admissions to Olive View Sanatorium. *Am. Rev. Tuberc.*, Sept., 1944, 50, 214-222.

The consensus of those experienced in diseases of the chest is that only by roentgenography can minimal and at times even more advanced pulmonary tuberculosis be diagnosed. Thus a chest examination is inadequate and incomplete unless it includes a roentgenographic study. Furthermore, wider use of chest roentgenography, both in survey and in all hospital admissions, would result in the uncovering of more minimal tuberculosis and would improve remarkably tuberculosis control.

The effect of preinduction and isolated pre-employment chest roentgenographic examinations in Los Angeles County on admissions to Olive View Sanatorium has been to produce an absolute and relative increase in the number of males admitted, thereby reversing the prewar predominance of females. The immediate five year prewar ratio of females to males, 1.26, was actually reversed to 0.85 in the period from January 1, 1942 to April, 1943. Despite this increase there was no change in the incidence of far advanced disease among the entire male group admitted. This does not indicate a diagnostic failure attributable to routine chest roentgenography, but demonstrates that few with minimal disease, more with moderately advanced and a high percentage with far advanced disease enter a sanatorium.—*John R. Haman*.

MORA, J. M., ISAACS, H. J., SPENCER, S. H., and EDIDIN, L. Posterior mediastinal goiter. *Surg., Gynec. & Obst.*, Sept., 1944, 79, 314-317.

Partially intrathoracic goiters occur rela-

tively often, especially in areas of endemic goiter. Their incidence is placed at about 12 to 20 per cent. Completely intrathoracic goiters are much rarer. The rarest of the intrathoracic goiters is the type found in the posterior mediastinum. Only 6 such cases have been previously reported.

The intrathoracic thyroid masses are practically always of the adenomatous type. Lahey and the Criles have repeatedly stated that they have never seen a diffuse goiter (exophthalmic goiter, primary hyperthyroidism) become truly intrathoracic.

The descent of these thyroid masses into the chest is facilitated by a number of factors. These include breathing, swallowing, muscular activity in flexing and rotating the head, non-resistance of the more pliant structures of the thoracic inlet, and gravity.

Clinically, the patients with this lesion fall into one of four groups: (1) those with no symptoms; (2) those exhibiting signs and symptoms of thyrotoxicosis; (3) those exhibiting pressure symptoms; (4) those with the combination of pressure symptoms and toxicity.

In the Cleveland Clinic series, hyperthyroidism was present in 50 per cent of all patients operated upon for intrathoracic goiter. Cough, dysphagia, changes in the quality of the voice and hoarseness are rare. The esophagus and recurrent laryngeal nerves are rarely involved. One should suspect a malignant lesion if there is any involvement of the recurrent nerves.

In the case reported, the roentgenogram disclosed a large globular mass occupying the right upper thoracic cavity; on lateral views this mass was seen to lie in the posterior mediastinum. The diagnosis at this time was thyrotoxicosis and the mass was believed to be a large intrathoracic goiter, although the roentgenologist felt that the diagnosis of a neuroblastoma could not be definitely excluded.—*Mary Frances Vastine*.

BLADES, BRIAN, and DUGAN, DAVID J. Tuberculosis of the posterior mediastinum. *Am. Rev. Tuberc.*, July, 1944, 50, 41-47.

The varied clinical nature of tuberculosis makes it necessary to include the disease in the differential consideration of a chronic obscure lesion in almost any part of the body. There is no doubt that, until quite recently, many patients with bronchiectasis, bronchogenic carcinoma, as well as other chronic pulmonary diseases have been institutionalized and spend

their remaining days in tuberculosis sanatoria. Until surgical treatment of pulmonary disease became feasible, differentiation between far advanced pulmonary tuberculosis and bronchogenic carcinoma or bronchiectasis was chiefly of academic interest. Now, if accumulated data suggest that a lesion is a tumor, every effort is expended to establish the diagnosis—even to the use of diagnostic thoracotomy. If one waits for truly diagnostic signs and symptoms, the tumor is generally inoperable. Moreover, the risk of open thoracotomy is trivial compared to the dangers of untreated thoracic tumors.

It is inevitable, however, as more thoracotomies are performed to identify masses of unknown etiology that a few inflammatory lesions will be mistaken for tumors and excised. In fact, preoperative diagnostic errors have led to excisions of calcified laminated abscesses, tuberculomata, etc., in the past. Nevertheless, the underlying principle of early removal of a tumor mass when ordinary diagnostic methods fail to reveal the true nature of the lesion is still sound. Moreover, many of these inflammatory masses would, in all likelihood, cause trouble later.

While it is not so difficult to distinguish inflammatory from neoplastic disease in the mediastinum as it is in the lungs, considerable opportunity exists for confusing tuberculous nodes with lymphatic tumors. Operative intervention is seldom advocated in this group; thus the question of surgical excision seldom arises. Rarely, tuberculosis produces a lesion in the posterior mediastinum the nature of which is not suspected despite careful study by every facility available.

The authors report such a case. A large posterior mediastinal tumor was discovered and preoperatively diagnosed as a primary nerve tumor. It was surgically excised, and to the complete surprise of all the physicians who had examined the case, the pathologist reported the finding of tuberculosis.

Evidence suggests, and follow-up of the authors' case seems to substantiate this, that extirpation of a well encapsulated tuberculous lesion will not cause dissemination of the disease.—*John R. Hannan.*

AUERBACH, OSCAR. Perforation of tuberculous lymph nodes into the trachea and bronchi. *Arch. Otolaryng.*, June, 1944, 39, 527-532.

In the course of routine autopsies on 1,656 tuberculous patients, the author has observed

perforations into the trachea and the bronchi, 22 (1.3 per cent) times.

Age. The youngest person was one and one-half years of age; the oldest, fifty-seven years. The fact that the majority of patients (12) were more than twenty-one years of age is in contrast to the distribution given in the majority of reports, namely, that the perforations occur chiefly in children.

Race. Sixteen of the 22 patients were Negroes.

Number and Site of Perforations. In 13 of 22 cases a single rupture occurred, and in 9 instances, two or more perforations were present. The perforations occurred mainly in the region of the carina. The multiple perforations took place not only in multiple areas of the air passages but also into the gastrointestinal tract, particularly into the esophagus.

Pathologic Appearance. In 7 cases, a calcified lymph node perforated the lumen of the air passages. Although the rupture of calcified nodes is seen more frequently in adults, it occurs also in children.

The development of emphysema in the mediastinum, extending into the neck from the rupture of a tuberculous lymph node into the air passage was first described by Benda in 1902.

Microscopically the inner wall of the perforation, as well as the inner wall of the liquefied lymph node, is lined by a zone of caseation or by a pyogenic membrane.

Clinical Observations. In none of these cases was there a dramatic, rapid course ending in death due to suffocation. These clinical findings are in contrast to those in the vast majority of reports in the literature.

Fifteen of the 22 cases showed a progressive caseous process of the lymphatic system. Roentgenograms of the chests of most of these persons revealed a widening of the mediastinum due to an enlargement of the tracheobronchial lymph nodes. In only 2 of the 15 cases was there a cavity present in the lungs before the rupture of the lymph node.

There were two events which often followed the perforation. One of these was the sudden appearance of tubercle bacilli in the sputum or gastric contents; the other was a bronchogenic dissemination from the aspiration of the caseous contents into the pulmonary parenchyma.

Healing. The author's findings cause him to doubt that the softened caseous material can be completely expectorated with subsequent complete healing.

Summary and Conclusions. (1) Adhesion of

the lymph node to adjacent structures is an important bar to the development of tuberculous mediastinitis. (2) The systemic disease in the cases studied was usually found to be a fulminating lymphohematogenous tuberculosis in which cure of the general infection and necessarily, therefore, of the local tracheobronchial complication was unlikely. An infrequent but important exception occurred in the cases in which a calcified particle, in itself the end stage of a healing process, was the source of the perforation. In these cases the normal respiratory mobility of the bronchial tree was probably of chief importance in the rupture of the lymph node.—*Mary Frances Vastine.*

NATHANSON, L., FRENKEL, D., and JACOBI, M. Diagnosis of lipoid pneumonia by aspiration biopsy. *Arch. Int. Med.*, Nov., 1934, 72, 627-634.

Ten patients who had a history of receiving liquid petrolatum for many years and who had suggestive roentgenograms pointing toward the diagnosis of lipoid pneumonia were investigated by means of aspiration biopsies. The material aspirated from the lungs of 5 of the 10 patients gave smears containing the characteristic lipoid macrophages.

The histologic response of the lungs to liquid petrolatum is said to be as follows. The droplets of oil entering the alveolar space act as a chemical and mechanical irritant. Soon mononuclear cells appear and phagocytose the oil droplets. At first these cells take on a foamy appearance; later in the course of imbibition they resemble ordinary fat cells. At first round or oval, they become bulky and of irregular contour, depending on the number of oil droplets phagocytosed. The latter press the nucleus toward the periphery but retain their subdivision for a long time, possibly until the cells disintegrate. In this stage one finds giant cells and fibrosis. As time goes on the fibrosis increases and the oil of the disintegrated lipophages becomes entrapped in the meshwork of the fibrous tissue. If the amount of fat is considerable and if fibrosis and giant cell formation are so abundant as to form a tumor one speaks of a paraffinoma. The latter stage was not encountered in this series of cases.

Roentgenographically the pulmonary lesion was not characteristic, but the infiltration, as a rule, involved the lower lobes of both lungs and particularly the lower lobe of the right lung. The mesial portion of the latter lobe adjacent

to the heart was the earliest site of involvement. The infiltration then spread to the dependent portions of the lobe above the diaphragm. The process varied in character from patchy infiltration to dense consolidation with fibrosis. There was little change in the lesion over prolonged periods.—*J. J. McCort.*

PIRKLE, H. B., and DAVIN, JULIA R. Loeffler's syndrome; transient pulmonary infiltrations with blood eosinophilia. *Am. Rev. Tuberc.*, July, 1944, 50, 48-51.

In 1931 Loeffler described a transient pulmonary infiltration associated with a high blood eosinophilia. The syndrome consists of asthma with a cough, eosinophilia ranging from 10 to 60 per cent, low grade fever accompanied by mild leukocytosis and an elevated blood sedimentation rate. Despite the relative absence of chest signs, the roentgen features are striking. They consist of pulmonary infiltrations—usually in the lower lung fields. The infiltrates disappear rapidly and do not cavitate. Subsequent observers have stressed, frequently, that the infiltration is based on an underlying allergy.

A case report follows. The authors' patient differed from many other cases reported in that she had no asthma, and the fleeting pulmonary infiltrations continued to migrate a rather long time, eight months, before the lung fields demonstrated complete clearing by roentgenographic examination.—*John R. Hannan.*

YOSKALKA, J. S. Atypical pneumonia simulating pulmonary tuberculosis. *Am. Rev. Tuberc.*, May, 1944, 49, 408-413.

For many years it has been the teaching of the medical profession to view a patient, subacutely ill, with roentgenologic evidence of infiltrations in the upper lung fields, as probably tuberculous until proved otherwise. According to Slack, bronchiectasis, asthma, pulmonary carcinoma, pneumoconiosis, cardiac hypertrophy and pulmonary abscess are the non-tuberculous lesions most frequently misdiagnosed as pulmonary tuberculosis.

Reports of the past several years indicate that atypical pneumonia not infrequently can produce lesions indistinguishable from pulmonary tuberculosis on the roentgenogram—particularly when the upper lung fields are involved. Approximately 7 to 10 per cent of cases with atypical pneumonia have upper lobe in-

vovement. Seven such cases were among the author's 96 cases of atypical pneumonia. Two of these 7 cases are reviewed briefly, and 1 case of pulmonary tuberculosis originally diagnosed as atypical pneumonia is presented.

The author concludes that any patient with an apical lesion failing to demonstrate clearance on roentgenographic examination within twenty days from the initial study should be suspected of pulmonary tuberculosis. Furthermore, sputum studies are indicated in all doubtful cases. If lesions persist for twenty days from the onset of symptoms, and routine sputum studies are negative for the tubercle bacillus, sputum and gastric concentrates, as well as guinea pig inoculations, are indicated. Because of the apparent increase in atypical pneumonia, early differential diagnosis is mandatory.—*John R. Hannan.*

NEEDLES, ROBERT J., and GILBERT, PHILIP D. Primary atypical pneumonia; report of 125 cases, with autopsy observations in one fatal case. *Arch. Int. Med.*, Feb., 1944, 73, 113-122.

This paper is a study of atypical pneumonia with analyses based on 125 cases. There was 1 fatality in the group and the autopsy observations are presented in detail.

The earliest appearance of changes detectable in the roentgenograms of the chest in these cases is on the second or third day. The symptoms are usually in advance of the initial roentgen changes just as in the later stages of the disease the roentgen changes are far in advance of changes in the clinical appearance of the patient. In several cases in which examinations were made in the first twenty-four hours of the illness no demonstrable changes were noted and the serial films thereafter demonstrated the gradual development of the pulmonary involvement. The authors found that the first changes take the form of a faint and usually localized exaggeration of the peribronchial markings, so that they have a streaked or linear appearance. The hilar markings are usually prominent and the changes may be projected into the pulmonary field from one or both hilar regions. There seems to be no preference for one lung over the other but the disease more commonly affects the lower pulmonary field. The mild attacks are usually unilateral and the more severe ones are generally bilateral. The earliest changes do not ordinarily extend beyond the middle of the lung and may cling closely to the lower mediastinal

border. The subsequent changes are extensions of the early picture. The markings increase in prominence and the area exhibits a mottled homogeneous increase in density.

Clear cut shadows such as are present with lobar pneumonia are seldom seen. Pleural thickening or evidence of pleural exudate is rare, having occurred in but 1 case in this series. In the more severely ill patients, those having marked dyspnea, cyanosis and large amounts of sputum, roentgen examination revealed a diffuse, mottled infiltration resembling miliary tuberculosis. In 1 case in the series it was difficult to distinguish the lesion from that of a primary tuberculosis complex. The author states that in many cases there is little to choose in the roentgen picture between primary atypical pneumonia and various of the fungus infections or pneumoconiosis.—*J. J. McCort.*

GRIER, GEORGE S., III. Importance of bronchography in cases of unresolved pneumonia. *Arch. Int. Med.*, June, 1944, 73, 444-448.

This is a statistical study of 40 patients with bronchiectasis. In this series of 40 patients 9 were referred to the clinic for persons with diseases of the chest because of a history of chronic cough, hemoptysis, or recurrent colds in the chest, while the remaining were admitted to the hospital with an initial diagnosis of primary atypical pneumonia.

Roentgenograms demonstrated stringy and mottled densities in the lower lobes of the lungs, usually unilateral and radiating out from the hilum toward the diaphragm. Lateral roentgenograms of the chest frequently revealed a pneumonic process behind the diaphragm or a cardiac shadow which could not be seen in the posteroanterior exposure.

Bronchographic studies were done in cases in which resolution failed to occur in four to six weeks and iodized poppy seed oil was injected into both sides even when the pneumonic process was unilateral. Studies with iodized oil are contraindicated in the period of acute pneumonitis since this procedure may produce an exacerbation of the acute process.

In summarizing the statistical data it is found that the distribution of bronchiectasis was usually unilateral (30 cases) and most frequently involved the lower lobe of the left lung (20 cases, or 50 per cent). The most frequent type of dilatations demonstrated were tubular and fusiform with 19 and 15 cases respectively. Only 6 cases of the saccular form are noted.

The author concludes that bronchographic study should be done in all cases of pneumonia which fail to resolve in a reasonable period, which is about four to six weeks.—*J. J. McCort.*

SHIELDS, D. O. Tuberculous pneumonia. *Am. Rev. Tuberc.*, Aug., 1944, 50, 122-130.

In its essence this report represents an analysis of treatment methods in 52 patients with tuberculous pneumonia. Generally, three major treatment plans are open for consideration: (1) immediate pneumothorax; (2) delayed pneumothorax; (3) bed rest until caseated areas have liquefied and then pneumothorax or thoracoplasty to close cavities and control infection.

From his studies the author, realizing the fallacy inherent in statistics on a small series, concludes:

1. Immediate pneumothorax appears to produce the better results when compared with bed rest in cases of partial consolidation with moderately high fever and moderately severe toxemia.

2. Some cases demonstrating roentgenologic homogeneous consolidation will respond slowly to pneumothorax.

3. Generally, in extensive, complete consolidation collapse is not effective and pneumothorax will not influence the disease progress.

4. Patients showing partial consolidation with a low grade fever and mild symptoms may be observed during strict bed rest and followed by institution of a pneumothorax if extension occurs or symptoms increase.

5. Early pneumothorax in tuberculous pneumonia does not increase the percentage of empyemata.

6. Adhesions appear to be slightly less extensive if pneumothorax is induced early.

7. Empyema develops more frequently when extensive adhesions are present.

8. Re-activation of tuberculous pneumonia, both while pneumothorax is being given and following lung re-expansion, occurs in a high percentage of cases.

9. Thoracoplasty probably should follow pneumothorax if collapse is inadequate due to adhesions or in the event that caseation is extensive. In selected tuberculous pneumonia cases thoracoplasty, even as a primary measure, may be tolerated better than reports indicate.—

John R. Hannan.

THORNTON, T. F., JR., ADAMS, W. E., and BLOCH, R. G. Solitary circumscribed tumors of the lung. *Surg., Gynec. & Obst.*, April, 1944, 78, 364-370.

There is a group of primary lung tumors that arise in smaller peripheral bronchi. They give rise to a rather indefinite group of symptoms, have a characteristic roentgen picture and are quite easily confused with solitary metastatic tumors and infections in the lung. These solitary circumscribed lung tumors constitute about 25 per cent of all primary lung tumors. Included in this discussion are 23 patients seen at the University of Chicago Clinics in the past ten years with a solitary rounded lesion that was at least 2 inches in diameter in the lung. The authors have included only patients in whom microscopic proof of the diagnosis was obtained or in whom certain clinical features made the diagnosis fairly certain.

One table in the article lists the diagnoses in this group of patients. Seventeen of the 23 rounded opacities demonstrated on roentgen examination were malignant lung tumors. Only 3 were metastatic; 14 were primary in the lung. One patient had a benign lung tumor. Such a tabulation emphasizes three important points:

1. So-called cannon-ball tumors of the lung, if seen as solitary lesions, are most likely primary in the lung.

2. Metastatic tumors to the lung are usually multiple when demonstrated clinically.

3. Highly differentiated neoplasms are relatively common among the primary lung tumors.

Certain other interesting points brought out in this article include:

1. The most common error made in this series was in the diagnosis of tuberculosis. Two patients were operated on for a solitary circumscribed lesion which was later found to be a tuberculoma; in 2 other patients the clinical diagnosis of tuberculoma was made because of calcium deposits in the lesion.

2. The clinical history and physical examination were of less aid in this series of patients than is usually the case in diseases of the chest.

3. Roentgenoscopic and roentgenographic examinations demonstrated every tumor in the series and gave some clues as to the type of the lesion. Calcification within the lesions indicated tuberculosis. (It is noteworthy that in not one of the 4 cases of tuberculosis were tubercle bacilli demonstrated in the sputum.)

4. Bronchoscopy was done in 12 patients but in only 2 was a positive biopsy obtained.

5. The almost complete failure of the usual aids to make an accurate diagnosis in these cases suggests very strongly the use of early exploratory thoracotomy as a diagnostic procedure.

Differential Diagnosis.

1. Metastatic tumors. Actually, the only way to make the diagnosis is to find the primary lesion.

2. Tuberculosis. In some cases, there will be other evidence of infection with acid-fast bacilli in the lung fields. Calcification is never seen in a malignant tumor although it may be present in benign lung tumors. If a cavity is demonstrated and no tubercle bacilli are found a neoplasm must be strongly suspected.

3. Chronic lung abscesses, in the absence of a definite history, can be diagnosed only by biopsy at thoracotomy.

4. Mediastinal lesions offer the greatest problems in differential diagnosis.

5. Substernal thyroid.

6. Lymphomas.

7. Aneurysms.

8. Bronchogenic and gastric cysts.

9. Low grade mediastinal abscesses, neurofibromas, chest wall tumors, and so forth.—*Mary Frances Vastine.*

REISNER, DAVID. Boeck's sarcoid and systemic sarcoidosis (Besnier-Boeck-Schaumann disease); a study of thirty-five cases. Part I. Clinical observations. *Am. Rev. Tuberc.*, April, 1944, 49, 289-307; May, 1944, 49, 437-462.

Because so many diverse sources have furnished observations from which the composite picture of sarcoidosis has developed, its nomenclature has become unwieldy. Several of the terms used in describing this disease are: multiple benign sarcoid, benign miliary lupoid, lupus pernio, benign lymphogranulomatosis, non-caseating tuberculosis, Besnier-Boeck's disease, Schaumann's disease. In the first two sections of this paper are presented the clinical observations in a study of 35 cases of sarcoidosis. The majority of the patients were Negroes—tending to confirm the observation that in the United States the disease occurs with greater frequency in Negroes than in white persons.

While sarcoidosis is essentially a widespread disseminated disease, the classical picture, in-

cluding characteristic cutaneous and osseous lesions associated with involvement of the lymphatic system, is present in the minority of patients. More frequently, the lesions seem limited to the visceral organs and are associated with a generalized lymphadenopathy. The most common findings are those of pulmonary involvement in combination with systemic lymphadenopathy. The marked variations in clinical manifestations are due, in part, to the protracted course, the tendency to spontaneous regression and the occurrence of new phases.

In this group of 35 patients there were 17 demonstrating lymphadenopathy in combination with pulmonary involvement. In the remaining 18 patients there were more or less widespread systemic manifestations associated with lymphatic pulmonary involvement.

While the roentgenologic changes in the lungs are extremely variable in extent and distribution, the following descriptions are representative of the principal types: (1) discrete, diffusely disseminated, small, nodular foci which may be identical with those observed in acute miliary tuberculosis. The foci may be evenly distributed throughout both lungs or more pronounced in the midportions; (2) diffuse or localized, linear or strand-like interstitial ("peribronchial-perivascular") densities; (3) patchy, coalescent densities, usually in combination with widespread linear and discrete nodular shadows. In addition to these changes, definite roentgen evidence of mediastinal and tracheobronchial lymph node enlargement was demonstrable in 30 of the 35 cases.

Cutaneous sarcoid occurred in 40 per cent of the series. Three main forms were observed: the discrete nodular, the large nodular, and the diffuse infiltrating, plaque-like variety. A combination of these forms was seen occasionally.

Roentgen evidence of bone involvement was observed in one-fourth of the group. The typical lesion is the "so-called" osteitis tuberculosa multiplex cystoides of Jüngling. Occasionally other forms are seen, i.e. (1) circumscribed—consisting of punched out, ray-transparent areas of bone destruction, usually medullary; (2) diffuse—reticulated, lace-like pattern of bone destruction with expansion and thinning of the cortex. Although the osseous changes are most common in the phalanges of the hand and feet, other bones may be involved occasionally. Extension into the joints is uncommon; moreover, bone and skin lesions frequently occur concomitantly.

Rarely, the heart may be involved by direct invasion, but the more common cardiac manifestation is right heart failure secondary to extensive pulmonary changes.

Sixty per cent of the group reacted negatively to the intracutaneous Mantoux test using up to 1 milligram of old tuberculin, and about one-fourth of the group demonstrated serum protein levels above 7 grams per cent.

Regression of the lesions, even to the point of complete disappearance of objective manifestations, was the outstanding feature in 9 cases. In 5 patients, the lesions became stationary, and in 9 others, the disease was progressive leading to death in 7 instances. Five of these 7 demonstrated evidence of tuberculosis at autopsy, thus indicating a possible relationship between these two morbid conditions.

In differential diagnosis, Hodgkin's disease and disseminated hematogenous tuberculosis deserve particular consideration.

There is no effective treatment for sarcoidosis available at present, but a variety of therapeutic agents have been used empirically with some success.—*John R. Hannan.*

SELLORS, T. HOLMES, BLAIR, L. G., and HOUGHTON, L. E. Diagnosis and treatment of lung abscess; symposium. *Brit. J. Radiol.*, June, 1944, 17, 165-176.

The three participants in this symposium are the surgeon, roentgenologist and physician at the Thoracic Unit at Harefield. Sellors pointed out that the one of the many forms of lung abscess that interests the surgeon is solitary putrid abscess of the lung. The microscopic infectious material is generally aspirated from dirty tooth sockets or the nasopharynx. It enters a small terminal air tube and blocks it and atelectasis, infection, breaking down of tissue and suppuration ensue. It is frequently believed that abscesses occur chiefly at the base, but as a matter of fact the commonest sites are the posterior part of the upper lobe and the apex of the lower lobe. An outline and diagram of the course of the sublobar bronchi which explain this localization are given.

The mortality in treatment of lung abscess is 25 to 40 per cent. This can be improved only by early drainage. It is customary to delay six to eight weeks for conservative or postural treatment. The surgeon should be allowed to see all cases as soon as they are recognized and join in the decision as to treatment.

Roentgen diagnosis can generally be made if

the clinical picture is considered in connection with it. Localization is of primary importance and lateral roentgenograms are absolutely necessary for this purpose. The radiologist and surgeon should screen the patient together to determine the exact site of the abscess. If there is fluid over the suspected area the aspirating needle should not be used. Once the abscess is located the patient should be placed in such a position that it is dependent. If two-stage drainage is practiced a metallic marker should be placed in the bed of the resected rib among the packing used to promote adhesions. In this way the accuracy of the approach can be checked by anteroposterior and lateral views before the second operation. Control of healing which cannot be visualized directly can be helped by filling the cavity loosely with gauze soaked in radiopaque oil. If a fistula persists the whole problem should be re-examined in order to exclude the possibility of malignancy, tuberculosis or congenital lesion.

Blair defined four groups of lung abscess: the acute pyogenic abscess, suppurative chronic pneumonia, pyemic abscesses, frequently multiple, and chronic lung abscess. The pyogenic lung abscess usually shows a cavity containing a fluid level, situated peripherally with surrounding reaction or consolidation. The conditions to be differentiated from this form of lung abscess may be extrapulmonary or intrapulmonary. The commonest extrapleural conditions are pleural effusion and diaphragmatic hernia. The intrapulmonary conditions are lung cysts, due to infection in congenital abnormalities and disintegration of lung tissue due to cancer or tuberculosis or occasionally syphilis or actinomycosis. Roentgenograms are given illustrating these differential diagnoses.

Pyemic abscesses are often multiple and may occur anywhere in the lung. Each resembles an ordinary pyogenic abscess except that there is not so much surrounding reaction. Chronic lung abscesses may exist for many years without showing roentgen signs. They are not merely acute abscesses that have been present for a long time but they are abscesses that have partially healed and in the process have become epithelialized. There are many cavities communicating with the bronchial tree by numerous fistulae, sometimes giving the roentgen appearance of an ordinary localized bronchiectasis such as is often seen after the healing of an area involved in suppuration of the lung. It is usual to differentiate between putrid and non-

putrid abscesses of the lung but if the sputum is not offensive it should suggest to the roentgenologist that the condition is one of those mentioned above and not a pyogenic lung abscess.

Houghton discussed the medical aspects of abscess of the lung and concluded that non-surgical cases of lung abscess should be treated along the same lines as the general sanatorium treatment of tuberculosis, that is by a carefully regulated life under open-air conditions designed to increase general fitness and resistance. It is hoped that penicillin may prove useful in abscess of the lung when it becomes available for that purpose.—*Audrey G. Morgan.*

HODSON, C. J. Four primarily radiological lesions found in traumatic chest cases. *Brit. J. Radiol.*, Oct., 1944, 17, 296-299.

Descriptions of four types of traumatic chest lesions are given which were found frequently in a series of 250 thoracic casualties; so far as the author knows they have never been described before.

The first is solid missile tracks. A missile may pass through lung tissue and leave no roentgen evidence but in 12 of the cases there were radiopaque linear shadows along the path of the missile. When viewed at right angles they appear as definite bands along the track of the missile but when seen end-on or obliquely they appear as small oval or rounded shadows. They may lead to the discovery of foreign bodies otherwise invisible behind the heart shadow or beneath an effusion.

Other missile tracks are not solid but contain air. They differ from the solid tracks only in the fact that there is a bronchus somewhere along their course which drains the blood away and air takes its place. They must be differentiated from tuberculous lesions.

Extrapleural hematoma are found in rib fractures and in cases of foreign body in or just inside the ribs. These extrapleural collections of blood may become infected, and if they do they can be drained without involving the pleural cavity and the danger of empyema be avoided.

Contusion of the lung may occur after non-penetrating injuries of the chest wall. It causes an early clouded appearance which for the few days before it clears may resemble an inflammatory condition or a pleural effusion. It may obscure lung detail for the first four or five days after an injury and may cause hemoptysis.

Illustrative roentgenograms are given.—*Audrey G. Morgan.*

BOBROWITZ, I. D. Mediastinal herniation in artificial pneumothorax. *Am. Rev. Tuberc.*, Aug., 1944, 50, 150-159.

The mediastinum contains two weak areas, sites of mediastinal hernia predilection—the one anterior and the other posterior. Herniation, bulging or ballooning of the mediastinal parietal pleura across the midline occurs most commonly in the anterior mediastinum behind the sternum between the second and fourth sternocostal articulations where the right and left mediastinal parietal pleura are in apposition. There, areolar tissue, a few lymph nodes and vessels and small vascular twigs offer little resistance to herniation. Less frequently, posterior mediastinal herniation takes place between the dorsal spine and aorta behind and the heart and esophagus in front. Occasionally with extreme degrees of herniation, serious complications, even death, ensue.

The unusual and interesting features of the single case reported are:

1. In a patient with a left artificial pneumothorax, a mediastinal herniation extended across the midline into the right chest, reaching to the dome of the right diaphragm and into the right apex.

2. When, to the left artificial pneumothorax, a right artificial pneumothorax was added, bilaterality of the mediastinal hernia became evident. Its size and appearance varied with phases of respiration.

3. A diagnostic problem arose in attempting to differentiate an apparent right spontaneous pneumothorax from a left mediastinal herniation. The diagnosis was established as a left mediastinal herniation by noting an entirely different shape to the right lung's apex after right artificial pneumothorax was established; and, second, by the installation of saline into the pneumothorax space. Roentgenograms and fluoroscopic observation in the decubitus position demonstrated the saline at the right apex, thus indicating that the fluid was free to flow from the left hemithorax to the right through the herniation space.—*John R. Hannan.*

GOLDMAN, ALFRED, and ROTH, HAROLD. Spontaneous pneumothorax: a report of three unusual cases. *Ann. Int. Med.*, Dec., 1944, 21, 1011-1021.

Three case studies are presented and discussed. All three developed spontaneous pneumothorax and each exhibited an unusual complication. The first case is that of a fifty-one year old male with previously unrecognized cystic disease of the lungs. The removal of a large amount of air and the injection of the patient's own blood into the pleural cavity resulted in a rapid clinical cure. It was thought that this case presented congenital cystic lesions because no definite etiological factor could be found in the history which would indicate that the cysts were acquired. In this patient the pneumothorax was first deflated and then 15 cc. of the patient's own blood injected. Other substances which may be used are 30 to 67 per cent glucose, iodized oil, 0.5 per cent solution of silver nitrate, oil of turpentine, guaiacol in iodoform, iodized talc, and plain talc.

The second case was that of complete atelectasis of the upper lobe of the left lung, associated with a spontaneous pneumothorax. Pneumothorax had been present for eleven months. The collapsed lung rapidly re-expanded following bronchoscopy and there was evidence of disease in the lungs following re-expansion. A careful survey of the literature shows only one previous report of atelectasis following idiopathic spontaneous pneumothorax.

The third case was that of spontaneous hemopneumothorax with recovery followed by a recurrence of the pneumothorax. This is the third reported case of this condition. It has frequently been stated that adhesions follow hemothorax and prevent recurrence. This accounts for the rarity of the condition.—*J. J. McCort.*

EISEN, DAVID. Right aortic arch with report of eight cases. *Radiology*, June, 1944, 42, 570-578.

Right aortic arch is a congenital defect which has been considered very rare but with the development of roentgen examination it may prove more frequent than has generally been believed. Fluoroscopic examination is necessary for its demonstration and it may not be detected on the flat roentgenogram.

A review of the embryonic development of the aorta and sketches of the circulation in a four week embryo are given. Arkin believes that right aortic arch is essentially a double aorta, representing a throw-back to the reptilian type of heart.

Eight cases are discussed and illustrated with roentgenograms. They were found incidentally in fluoroscopic examination of the chest for other conditions. None of them had caused any symptoms. As there is a vascular ring completely surrounding the trachea and esophagus, there may be more or less serious signs of compression. If a stenosis develops in the left fourth branchial vessel early in embryonic life before the right fourth vessel has evolved into the subclavian artery, then the right fourth branchial arch will develop into the functioning aortic arch; in that case the left subclavian artery and diverticulum represent an aborted left aortic arch and the obliterated vessel which joins them indicates the area of stenosis.

The essential features in the roentgenogram are that the shadow of the ascending arch of the aorta is on the right side, compressing the esophagus and displacing it to the left; the transverse arch is high up, crossing over the right bronchus, which is on a higher level than the left. This is an important point in the diagnosis of this condition. The trachea and esophagus bulge forward over the transverse arch of the aorta which is situated behind them. The shadow of the aortic arch is absent from its normal position and the conus region is unusually clear because the descending part of the aortic arch is not superimposed on it.

The roentgen demonstration of this anomaly is important not only because of the signs of compression which it may cause but because of the necessity of differentiating it from other and more serious abnormalities. The heart is not affected.—*Audrey G. Morgan.*

HOLMES, H. R. A case of patent ductus arteriosus associated with multiple pulmonary aneurysms and infective endocarditis. *Brit. J. Radiol.*, Oct., 1944, 17, 312-315.

Patent ductus arteriosus is now known to be a predisposing cause of subacute bacterial endocarditis; this disease, which is otherwise fatal, is sometimes cured by ligation of the duct. It is therefore important to make complete roentgen examination in cases of patent ductus arteriosus in order to determine the indications for operation.

A case is described and illustrated with roentgenograms. The author believes that roentgenograms of such a case have never before been published. The patient was a man twenty-six years of age who complained of lassitude and breathlessness on exertion with fortnightly

attacks of sharp pain below the sternum and right nipple. He was discharged after an illness lasting eleven months and returned a month later because two of his attacks of rigors and fever had been accompanied by hemoptysis. Roentgen and clinical examinations and the presence of a murmur in the left second and third interspaces with a systolic thrill led to a diagnosis of patent ductus arteriosus with infective endocarditis and pulmonary infarction. The patent ductus was ligated and the murmur stopped but two days later the patient died after a copious hemoptysis.—*Audrey G. Morgan.*

JOHANNSEN, M. W., and CONNOR, CHARLES A. R. Cor pulmonale with bilateral aneurysms of the pulmonary artery, interventricular septal defect, patent ductus arteriosus and terminal Ayerza's syndrome. *Ann. Int. Med.*, Feb., 1943, 18, 232-237.

Aneurysms of the pulmonary artery are said to be so rare as to constitute almost a curiosity. From 1905 to the present time there have been 28,180 autopsies in Bellevue Hospital and in only 1 previous case was this lesion found. The patient was a forty-four year old white woman with cyanosis of the entire body. She was dyspneic and orthopneic. She coughed frequently, raising blood-streaked sputum. The jugular veins were distended and filled from below. There was a loud harsh, systolic murmur heard both at the apex and the base. A short diastolic murmur was audible along the upper part of the left sternal border. The second pulmonic sound was accentuated. The blood pressure was 160/108. The liver was palpated about 5 cm. below the costal margin. A teleroentgenogram disclosed generalized cardiac enlargement, most marked along the right border and the outflow tract of the right ventricle. Dilatation and calcification of the right and left pulmonary artery were evident.

The patient died nine days after admission and at autopsy the heart was found to be markedly enlarged both to the right and left. The right ventricle was dilated and its muscle hypertrophied, measuring at its widest portion 1.5 cm. There was a defect in the interventricular septum, immediately below the auriculo-ventricular junction. The foramen ovale was closed. The aorta showed no evidence of syphilis. The aortic arch communicated with the pulmonary artery through a widely patent ductus arteriosus, which measured 1.2 cm. in

diameter and 1 cm. in length. The pulmonary conus, pulmonary artery and its branches exhibited a moderate, and in places, a severe degree of atherosclerosis with calcification. The left pulmonary artery was dilated prior to its entrance into the lungs. Its wall was thin and the aneurysm was filled with a gray, laminated clot which extended into the branch supplying the left upper lobe. Many of the smaller rami were either completely or partially occluded by the continuation of the above described thrombus. The extrapulmonary part of the right pulmonary artery was also dilated forming a sac which had a depth of 3 cm. and a length of 3.2 cm. Its lumen was partially obliterated by a huge thrombus.

The authors believe that the two congenital arteriovenous shunts necessitated increased work on the part of the right ventricle. These shunts were also largely responsible for the pulmonary hypertension shown clinically by the right-sided cardiac enlargement and the accentuated pulmonic second sounds and anatomically by the right ventricular hypertrophy.—*J. J. McCort.*

ABDOMEN

SAMUEL, ERIC. Review of Scandinavian literature on gastrointestinal diseases, 1939-1943. *Brit. J. Radiol.*, July, 1944, 17, 221-225.

Brief abstracts are given of the Scandinavian literature during this period. Holmgren in an article on sideropenic dysphagia or cancer of the hypopharynx described 2 cases, 1 of which proved to be cancer and the other sideropenic dysphagia. Frostberg recommended examination of the barium-filled esophagus in cases of goiter. Christiansen records 4 cases of short esophagus, 2 in elderly people and 2 in infants. In any case of carcinoma of the esophagus at an unusual site the possibility of short esophagus should be considered. Helghe Myhre discussed the significance of large niches in the stomach on the basis of 23 cases from the University Clinic in Oslo. Nine were carcinomatous and 14 benign. If there are no other signs of infiltration ulcers larger than 2.5 cm. in diameter are more apt to be benign than malignant. Forssman discusses 30 cases of benign tumor of the stomach seen in ten years and compares them with 931 cases reported by Muines and Geschickter. The roentgen diagnostic features are: smooth outline of the filling defect, normal movable mucosa over the tumor, large ulcer crater, softness and compressibility of the

tumor and peristalsis of the neighboring mucosa, and mobility of the tumor in relation to the wall of the stomach and the mucosa. Forssman also contributed an article on the roentgen diagnosis and treatment of sarcomas of the stomach, especially lymphosarcomas and reticulum cell sarcomas. The chief roentgen signs of sarcoma are that the growth is in the wall and not in the lumen of the stomach; the mucosa is intact with a bulging outline; the overlying mucosa is smooth; peristalsis is lost in the affected region at an early date and the tumor is centrally placed and the edges are flexible. Roentgen therapy with daily doses of 200-400 r up to a total skin dose of 2,500-3,000 r gives satisfactory results. Holta describes 3 cases of leiomyosarcoma of the stomach and says that roentgen differentiations of one form of benign tumor of the stomach from another is not possible. Nordentoft discusses the value of the barium enema in the diagnosis and treatment of intussusception in children on the basis of 440 cases. The two chief roentgen signs of successful reduction are complete filling of the cecum and inflow of the enema into the small bowel. The danger of rupture of the bowel is theoretical rather than practical. Skarby described a case of roentgen diagnosis of primary invagination of the appendix which he thinks is the first one recorded. Steinert, Hareide and Christiansen discuss the roentgen diagnosis of acute appendicitis on the basis of 104 cases. Fecaliths were found in the appendix in 10 cases. The distribution of gas in the cecum and colon varied greatly. Fluid levels in the cecum are a characteristic finding in acute appendicitis. Fluid and gas levels in the terminal ileum are also characteristic. There was a homogeneous density in the region of the appendix in 34 cases. Free fluid was demonstrated on operation in 83 cases. Free gas in the abdominal cavity is a conclusive sign of perforation. The flank stripe was seen in 6 cases. The psoas outline was obliterated in 13 cases. There was left convex scoliosis in 32 cases; the appendix was perforated in 10 cases, gangrenous in 4 and catarrhal in 3. There was inward bulging of the flank on the affected side in 14 cases. In 14 cases there was reduced excursion of the diaphragm on the left side. The roentgen signs may be visible as soon as four hours after the onset of the illness but in some cases they were not visible after ten hours, Holmgren described 2 cases of volvulus of the sigmoid, 1 of which showed gas and fluid levels in the cecum and

the rest of the large bowel. This is unusual. In the other an esophageal tube was passed through the rectum into the twisted loop, resulting in spontaneous reduction of the volvulus. The varieties of volvulus are illustrated. The loop may turn through any degree from 90° to 560°. Renander discusses the roentgen signs of tuberculosis of the rectum. This is rare but does occur and may be primary or secondary. It is generally sclerotic but may be hyperplastic. The rectum is contracted to form a narrow tube with deep excavations in the walls. If the rectum is contractile it indicates tuberculosis rather than carcinoma or syphilis. Buckhuis described a case of fistula between the duodenal cap and the bile duct, reviewing the literature and emphasizing the rarity of the condition. Ollsen discussed nursing as a source of error in cholecystography. The dye is excreted in the milk, causing poor concentration in the gallbladder. Moberg described a case of portal thrombosis which calcified and was diagnosed on the plain film. The article is beautifully illustrated. This case emphasizes the value of the plain roentgenogram of the abdomen. Selander reported 2 cases of embryonic tumor of the sympathetic nervous system, 1 in a child three years of age and the other in a female of twenty; the duration of the disease was two years in 1 case and three and a half years in the other. The condition must be differentiated from mycetoma and small-celled sarcoma and roentgen and even microscopic differentiation may be very difficult.—Audrey G. Morgan.

REINBERG, S. A. X-ray diagnosis in gunshot wounds of the abdominal cavity and its significance in field surgery. *Brit. J. Radiol.*, Oct., 1944, 17, 291-295.

It was not until toward the end of the war of 1914-1918 that surgeons began to recognize the importance of early operation in gunshot wounds of the abdomen; this was necessarily followed by an appreciation of roentgen diagnosis in these wounds, but little could be accomplished at that time on account of the imperfect roentgen apparatus in use.

During peace time of course nothing could be done about abdominal wounds but a beginning was made in the study of peace time abdominal conditions such as gastric and duodenal ulcers and acute intestinal obstruction. During the last few years before the war over 90 per cent

correct diagnosis was achieved in these conditions. This was rendered possible by the establishment of twenty-four hour service which was first instituted in the roentgen department of the Sklifassovsky Institute, Moscow, in 1932. So far as the author knows there is no such service anywhere except in the U.S.S.R. This service was continued after the war began, the soldiers being brought in quickly, generally in the first twenty-four hours, and often by plane.

Roentgen examination is of decisive importance in fixing the differential diagnosis between penetrating wounds, perforating wounds and tangential wounds. This is difficult or often impossible clinically. The roentgen diagnosis of pneumoperitoneum as evidence of injury of the intestine is of great importance. This, too, can often not be detected early by clinical signs. Operation is indicated as soon as it is established. Negative evidence is not always absolutely conclusive.

The condition found in injury of solid organs is hemorrhage and while the nature of an abdominal fluid cannot be demonstrated by roentgen examination it is safe to conclude that fluid in the abdomen soon after an abdominal wound is blood.

It is safe to say that the wider the use of roentgenology in gunshot wounds the greater the absolute and relative numbers of cases correctly diagnosed and properly treated. Of course the full use of roentgenology depends on the possibility of bringing apparatus as near the front line as possible and therefore tactical and administrative problems as well as medical ones are involved.—*Audrey G. Morgan.*

PACK, GEORGE T., and EHRLICH, HARRY E.

Neoplasms of the anterior abdominal wall with special consideration of desmoid tumors; experience with 391 cases and a collective review of the literature. *Internat. Abstr. Surg.*, Sept., 1944, 79, 177-197.

The present report is based on an analysis of 470 tumefactions in the locality of the anterior abdominal wall and includes 391 cases of neoplastic diseases.

Surgical Anatomy. The linea alba (the tendinous raphe which stretches down the middle of the anterior abdominal wall) is not perforated by lymphatic capillaries so that it partitions the deep lymphatic system of the anterior abdominal wall into right and left halves. Thus cross metastases of intramural tumors occur only when a malignant growth is

situated behind the transversalis fascia or the posterior rectus sheath, i.e., in the preperitoneal fatty areolar layer—a most unlikely location for a primary lymphatic metastasizing neoplasm.

Benign Tumor. Fifty-one per cent of the 470 tumefactions were benign—constituting the largest group. Of the 305 primary neoplasms, 80 per cent were benign and 20 per cent malignant. The sexes were almost equally affected. The ages of the patients varied from six weeks to seventy-seven years, the average age being thirty-three years.

Thirteen distinct morphological types of tumors were encountered. The common benign neoplasm in order of their frequency were lipomas (20 per cent), neuronevi, hemangiomas, epithelial papillomas, fibromas, neurofibromas, and keratoses or keratotic papillomas.

Primary Malignant Tumors. There were 63 primary malignant tumors. Primary and metastatic tumors occur with about equal frequency in this locality. The anterior abdominal wall is particularly vulnerable to secondary cancerous deposits because of its lymphatic and venous connections, especially with the peritoneal cavity and portal circulation through the umbilicus.

Carcinomas and sarcomas in this area occur with about equal frequency. Out of 17 cases of epidermoid carcinoma, 12 were engrafted on pre-existing tissue abnormalities (sinuses, scars, psoriatic lesions, etc.).

Cancers which have their origin in post-operative chronic draining abdominal sinuses or in laparotomy scars carry a grave prognosis.

Primary sarcomas are more frequently found than primary carcinomas. The more common tumors in order of frequency were neurogenic sarcomas, spindle-cell sarcomas, synoviomias, and rhabdomyosarcomas. The treatment of these tumors must consist of wide resection. Irradiation is a most valuable therapeutic adjunct.

There were 8 primary melanomas, 12.7 per cent of all primary malignant tumors in the anterior abdominal wall. Melanoma offers the gravest prognosis when it arises in the umbilicus. It is best treated surgically.

Metastatic Malignant Tumors. Metastatic cancer is most frequently situated in or about the umbilicus, is frequently multiple, may involve the abdominal wall bilaterally and frequently metastasizes to the regional axillary and inguinofemoral lymph nodes. (The features

of primary carcinoma are the exact opposite of these.)

In 22 cases, the first indication of lymphosarcoma, Hodgkin's disease, leukemia, or mycosis fungoides was tumefaction in the anterior abdominal wall.

Miscellaneous Lesions Simulating Tumors in the Anterior Abdominal Wall. There were 79 cases (16.8 per cent) of such lesions in the series. The most common non-neoplastic lesions are cysts (sebaceous, urachal, and sweat glands) and chronic nonspecific inflammatory masses. Less often encountered are nonmalignant radiation ulcers, fat necrosis, tuberculosis, and endometriosis. There were 2 cases of Boeck's sarcoid.

Desmoid Tumors.

Definition. Desmoid (from *deous*, meaning band and *eidōs*, meaning appearance) is essentially a hard fibroma situated in the flat muscles of the anterior abdominal wall. It occurs characteristically in young parous women and frequently recurs following limited surgical removal. It is unencapsulated and infiltrating and of fascial or aponeurotic origin.

Incidence. These tumors are rare. In this series they comprised 3.5 per cent of all tumefactions and 7 per cent of all benign tumors in the anterior abdominal wall.

Causative Factors. None could be determined. The one factor that appears to be of etiological significance is pregnancy.

Anatomy. The growth is almost always solitary and unilateral. These tumors show a tendency to infiltrate into joints and to become adherent to bone. The rectus abdominis was the muscle which was most frequently the site of this tumor. The vascular supply of desmoids is poor. The microscopic appearance is that of a fibroma plus the presence of bundles of striated muscle fibers in various stages of atrophy. The desmoid tumor differs from the ordinary fibroma in that it is often unencapsulated, possesses infiltrative tendencies, and attains considerable size. Characteristically, the desmoid tumor always compresses, invades and destroys muscle.

Diagnosis and Clinical Course. There are no special symptoms characteristic of these tumors. In the majority of the authors' cases, the neoplasm was located in the right lower quadrant. Bouchacourt's sign was demonstrated in almost every case. This sign is revealed by having the patient contract the muscles of the anterior abdominal wall by

flexing the head; following this maneuver, an intraperitoneal mass can no longer be palpated or, only very slightly, but an intramural mass becomes more prominent.

Desmoid tumors are slow-growing. Growth is progressive, however, and if of sufficient duration (from seven to ten years), the neoplasm may reach huge proportions, involve the entire abdominal wall, and penetrate into the retroperitoneal space or even into the abdominal cavity and pelvis.

Treatment. The treatment of choice is radical surgical excision. Radiation therapy has a definite place in the management of desmoid tumors (the effect is probably an indirect one due to suppression of ovarian function). This latter form of treatment should be reserved for inoperable cases, large tumors in poor-risk patients, and for those who will not consent to operation.

Prognosis and End-Results. Although desmoid tumors may undergo malignant transformation, no instance was encountered in which there were regional lymph node or distant metastases. In this series there were 4 cases in which the tumor recurred and 1 case in which there were two recurrences. All recurrences responded satisfactorily to radiation therapy.—*Mary Frances Vastine.*

SNELL, W. E. Radiographic abnormalities of stomach and colon in mental defectives. *Brit. J. Radiol.*, Aug., 1944, 17, 239-240.

During the course of miniature chest surveys in 2,035 mental defectives at an English hospital it was found that many of the patients showed an increased gas content of the stomach. Distention of an abnormal degree was found in 109 cases, or 5.3 per cent. Age seemed to have no effect on its incidence but it was almost twice as common in women as in men. The condition was found chiefly in cases of congenital mental defect and it was commoner in the more pronounced types of mental deficiency. This may be due partly to the fact that these patients are more vegetative, many of them being confined to bed. The abdominal walls are relaxed and constipation is common; the increased gas is probably due to general hypotonus of the intestines. Another possible factor is that many idiots have to be fed by attendants and this probably conduces to aerophagy.

In 3 cases out of the 2,035 the colon lay above the liver, separating it from the diaphragm. This condition is called falciform colon

and is due to a congenital defect of the falciform ligament of the liver. Multiple congenital defects are common in patients who are deficient mentally.—*Audrey G. Morgan.*

WILEY, H. M. Gastric ulcer, benign or malignant. *Am. J. Surg.*, July, 1944, 65, 104-111.

The author bases his report on a group of 43 cases of gastric cancer treated in the Department of Surgery of the Ellis Fischel State Cancer Hospital and considers the subject of relationship and differential diagnosis between gastric ulcer and cancer.

He found the average age to be 51.3 years for ulcers and 64.1 years for cancer but points out that material comes from an older age group. The average duration of symptoms for ulcer was 35 months, for cancer 13.9 months. Symptoms of upper gastric pain and distress, vomiting and weight loss were of little differential value but he believes that "absence of occult blood (in the stools) excludes cancer of the gastro-intestinal tract except that of the infrequent scirrhus form." While achlorhydria is found normally in 35 per cent of individuals in the seventh decade, he believes that an absent or low gastric acidity favors malignancy and that ulcerated gastric lesions with absent or low free hydrochloric acid should be operated upon immediately.

The most important single diagnostic procedure is roentgen examination and by it, in all but 10 per cent of the cases, differentiation may be made between a benign and a malignant lesion but he states operability cannot be determined from roentgen examination. The greatest accuracy of diagnosis is achieved by combined use of roentgen examination and gastroscopy, but usefulness of the latter is limited by difficulty of interpretation and length of study necessary to gain proficiency.

In the author's series 62.8 per cent of gastric cancers were in the prepyloric region, 11.7 per cent were in the fundus, 18.6 per cent involved the entire body of the stomach and 6.9 per cent were in the cardia. From these figures and also the findings of Allen, and of Kirklin and Holmes, he concludes that "resection should be done on all lesions of the greater curvature and prepyloric areas. Lesions on the lesser curvature should be watched carefully and in the age group above fifty years resection is the only safe course." No differential significance can be attached to the size of the lesion either in the roentgenogram or at operation but large ulcers

should be resected on the probability that they are malignant.

In spite of consideration of all diagnostic procedures, gastric ulcer or cancer cannot be differentiated in 10 per cent of cases and even at operation it may be impossible to determine the exact nature of the gastric lesion unless rapid frozen sections are studied.

His report includes details of history, examination and final diagnosis of 2 cases. In the first the lesion appeared benign even at operation but the microscopic report showed carcinoma. In Case II there was a large perforating ulcer on the posterior aspect of the stomach; this was thought at operation, and confirmed microscopically, to be benign. The article concludes with a well arranged table of useful differential features.—*Angus K. Wilson.*

PREISS, A. Case of peptic ulcer on the greater curvature of the stomach. *Brit. J. Radiol.*, June, 1944, 17, 182-184.

Peptic ulcer on the greater curvature of the stomach is very rare. David in a survey for the years 1914 to 1928 found only 24 cases reported in the literature. Many cases with the roentgen picture of ulcer and benign macroscopically on operation are found on histological examination to be malignant. Demole and Henny in 1939 stated that only 12 cases have been reported that have been proved microscopically to be benign.

A case is described in a man of thirty-four who had had heartburn frequently since youth and epigastric pain about two hours after meals since 1926. In 1938 laparotomy was performed but there was no history of any surgical operation. From then until 1940 he was free of symptoms but then began again to have severe pain after every meal and often vomiting. Roentgen examination showed the typical appearance of ulcer on the greater curvature with narrow folds converging toward the niche. Roentgenograms and a histopathological picture are given. The patient was under observation and treatment from November, 1942, to February, 1943, when on account of the severity of the symptoms, the failure of the ulcer to heal and the possibility of cancer, operation was performed. It showed a callous penetrating ulcer on the greater curvature; no sign of malignancy or evidence of a previous operation was found. Histopathological examination showed the scar of a healed chronic gastric ulcer with no signs of cancer.—*Audrey G. Morgan.*

ELKELES, A. Radiological observations and the description of a cardiac pouch in carcinoma of the cardiac end of the stomach. *Brit. J. Radiol.*, Aug., 1944, 17, 251-254.

Diagnosis of cancer of the cardiac end of the stomach is still difficult. The author describes several known roentgen signs of this condition and adds another which if confirmed by other investigators may prove valuable in the early diagnosis of cancer at this site. He found it in all of 5 cases examined. It is a pouch hanging from the lower end of the cardiac end of the stomach below the antrum cardiacum. It is roughly triangular in shape with the greatest density at the apex. It can best be demonstrated in the erect position and remains filled with barium for three and a half to four and a half hours. It must be differentiated from true cardiac diverticulum, which, unlike the pouch, has a uniform round shape, is the size of a cherry or sometimes larger, may be movable is not tender on pressure and holds the barium much longer. The peculiar shape, the unusual position and the pendulous character of the pouch are additional factors in differential diagnosis.

The 5 cases examined are illustrated with roentgenograms.—*Audrey G. Morgan.*

MCCARTY, RAY B., and PRESENT, ARTHUR J. Mesenteric pouch hernia simulating paraduodenal hernia. *Surg., Gynec. & Obst.*, June, 1944, 78, 643-648.

Intra-abdominal hernias are of such rarity that they often escape consideration in the differential diagnosis of acute or chronic intestinal obstruction, or recurrent slight digestive symptoms. A mesenteric pouch hernia occurring in a soldier with a history of three attacks suggestive of volvulus is described. The preoperative diagnosis based on the roentgenographic findings was a probable paraduodenal hernia. Because of the origin of this hernia near the duodenojejunal junction, it is discussed with paraduodenal hernias from the standpoint of etiology, symptomatology, roentgenography, and of treatment.

Etiology. 1. In 1899, Moynihan described 9 "duodenal fossae" in the vicinity of the junction of the duodenum and jejunum, some of which are frequently found, while others are very rare. He described right and left duodenal hernias and expressed the belief that an increase in intra-abdominal pressure started the formation of a hernia provided the proper fossa was pres-

ent and a loop of small intestine became engaged in the fossa.

2. In 1920, Andrews dissented from this opinion and presented evidence to support his thesis that "duodenal hernia is a congenital anomaly due to imprisonment of the small intestine beneath the mesentery of the developing colon." If rotation of the umbilical loop is not carried to completion he stated that a right duodenal hernia would be produced.

3. In 1935, Callander, Rusk and Nemir reported a case of so-called left duodenal hernia. In the embryological discussion they brought out convincing evidence that this type of large hernia is not a result of incomplete or malrotation but rather the result of invagination of an area of the descending mesocolon medial to the ascending branch of the left colic artery and inferior mesenteric vein by the jejunioileum while the descending colon is mobile and has not as yet fused with the primitive posterior parietal peritoneum.

Symptoms. Mesenteric pouch hernias are reported much less frequently than paraduodenal hernias. However, as the hernia reported here had its origin high in the mesentery to the small intestine in the paraduodenal region and exhibited the same symptoms as might be expected of a paraduodenal hernia, it seems fitting to include this case with paraduodenal hernia in a general discussion of symptoms: (1) bouts of intestinal obstruction; (2) vague, slight gastrointestinal distress; (3) no history of gastrointestinal distress; (4) occasionally, a soft palpable tumor. Percussion should give a resonant note and on auscultation gurgling peristalsis may be heard.

Roentgenography. Presented with the unusual finding of a smoothly outlined, clumped small bowel pattern, and with confirmatory decrease in mobility and motility, the diagnosis of a hernia in the region of the duodenojejunal junction should be suggested. Only by complete so-called "small intestinal" studies can the proper conclusion be obtained. Case and Upson stated that whenever the duodenum goes directly to the right and thence into the jejunum without the normal swing to the left, a paraduodenal hernia should be suspected.

Roentgenographically, the confusing conditions include peritoneal adhesions and a congenitally short mesentery. In the former, a more diffuse pattern is to be anticipated with sharper angulations and segmentations of the involved loops. Palpation, normal progress of

the meal and change in position of the loops in decubitus films should eliminate a short mesentery.

Treatment. The treatment of hernias occurring about the duodenojejunal junction is surgical.—*Mary Frances Vastine.*

FICARRA, BERNARD J., and DEGAN, WILLIAM B. Congenital atresia of the ileum, spontaneous perforation and multiple intussusception. *Am. J. Surg.*, July, 1944, 65, 123-126.

The authors present reports of 2 interesting surgical conditions which they encountered during their residency in King's County Hospital.

CASE I. This was a premature (eight months) infant who showed on the first post-partum day abdominal distention, unrelieved by gastric or rectal intubation. Clinical and roentgen (plain abdominal film) findings indicated small intestinal obstruction. At operation thirty-six hours after birth there were found (a) membranous obstruction of the ileum $3\frac{1}{2}$ inches from the ileocecal valve, (b) transverse rupture of the ileum 5 inches from the ileocecal valve, and (c) peritonitis. Death occurred ten hours after operation.

In discussion the authors stress the relative infrequency of this type of obstruction and the rarity of perforation proximal to the point of obstruction. They quote a report by Ladd and Gross in which 5 out of 41 similar cases survived operation. They also mention Farber's tests for the microscopic detection of swallowed vernix cells in the meconium; absence of such cells is presumptive evidence of intestinal obstruction.

CASE II. This patient was a twenty-three month old colored male who had constipation for five days prior to hospitalization but on alternate days during this period had passed small amounts of fecal material. Abdominal pain was manifested by flexion of thighs on abdomen, facial expression and holding the abdomen with his hands. Vomiting occurred twice during physical examination. No blood was passed per rectum. Plain film studies of the abdomen showed a soft tissue mass in the right upper quadrant and clinically there was a suggestion of a palpable mass in the right lower quadrant. A clinical diagnosis of intussusception was made. At operation seven days after admis-

sion a double intussusception was found, viz., of the terminal ileum into the cecum and of the cecum into the ascending colon. It was noted that there was extreme mobility of the right half of the colon. The obstruction was relieved and the bowel found to be viable. The appendix was removed and the cecum and terminal ileum were sutured to the posterior parietal peritoneum. Barium enema study four days after operation showed a normal large intestine. The authors, in their comment, state that multiple intussusception is usually of the ileo-ileocolic type and that ileo-cecal-cecal colic such as this are extremely rare. They believe that the relatively long, non-fatal progress in their case is indicative of a intussusception which reduced itself and then recurred.—*Angus K. Wilson.*

HENDERSON, NORMAN P. Diverticulitis and diverticulosis. *Brit. J. Radiol.*, July, 1944, 17, 197-203.

There is considerable confusion in the use of these terms and the author defines diverticulosis as a condition in which herniated mucosal sacs appear inside or outside the wall of the colon. Diverticulitis is an inflammation of such sacs. They may be caused by any condition which weakens the wall of the intestine but he believes they are most frequently produced by one or more attacks of inflammation. However, they may occur in association with cancer of the colon and in such cases he believes that the cancer is present first and weakens the bowel wall so that diverticula develop. This is contrary to the usual assumption that the diverticula precede the cancer. In support of his theory he describes a case in which the diverticula first became manifest but a comparison of later roentgenograms with the earlier ones showed that the carcinoma had been present first. These roentgenograms and those of other cases are reproduced and a colored plate is given showing the five stages in the development of diverticula: (1) the ripple border stage; (2) palisading; (3) pulsion diverticula; (4) retractable ballooning, and (5) permanent diverticula. For effective treatment these diverticula should be diagnosed in the early stages before the later and more serious changes develop. If diverticulosis has been diagnosed and no tumor growth found an examination by opaque enema should be made every year for the next three years. Often before the end of this time the development of a carcinoma can be observed. This is a form of preventive medi-

cine and should be practiced just as preventive dental examinations are. In more advanced cases the carcinoma is sometimes actually buried in the area of diverticulosis.

If the diverticulosis does not proceed to the second or palisading stage diverticulitis sometimes causes a fibrosis the final stage of which is a fibrous contraction with stenosis or stricture.
—Audrey G. Morgan.

JAMES, CHARLES F., JR. Dermoid cysts of the mesentery. *Am. J. Surg.*, July, 1944, 65, 116-119.

The author reviews the literature and reports the sixteenth recorded case of dermoid cyst of the mesentery. His case differs from those previously described in that two cysts were found, whereas, other writers had reported only one. The etiology, though possibly explained by several theories, remains obscure. These cysts may be located in any portion of the mesentery but are most frequent in the lower end of the ileum. The case reported was of a twenty-four year old American soldier who complained of lower abdominal pain, nausea and loss of appetite for two weeks; these complaints were sufficiently severe for two days preceding hospitalization to require medical consultation. There was slight weight loss but there were no symptoms indicative of gastrointestinal or urinary tract involvement. Temperature on admission was 100.5° F., pulse 100, erythrocyte count 4,840,000, hemoglobin 95 per cent, leukocyte count 20,000, with 86 per cent polymorphonuclears. There was a tender, fixed mass which occupied the right lower quadrant of the abdomen and extended across to the left of the umbilicus. On rectal examination it was high on the right side and outside of the rectum. The findings pointed to a probable appendiceal abscess and it was decided to postpone operation until this had been given an opportunity to become walled off. During the subsequent forty-eight hours, on a regimen of chemotherapy and intravenous feedings, the leukocyte count dropped to 9,000 with 71 per cent polymorphonuclears. Six days after admission the mass had changed in position and was ballotable. A plain roentgenogram of the abdomen showed a large, sharply defined, ovoid mass containing numerous areas of calcification in the right lower quadrant. It was not attached to bone and barium enema examination showed it outside of the colon.

From the roentgen studies a preoperative

impression of dermoid cyst was made and this was confirmed at operation, when two masses were found, one measuring 2 by 4 inches and the other 2 by 3 inches; they were approximately 3 inches apart in the mesentery of the distal 2 feet of the ileum. The smaller one had perforated and some of its contents had caused a localized peritonitis. The preoperative impression was confirmed by pathological study of the removed tissue.

The author points out that symptoms in association with mesenteric dermoids are due to complications such as obstruction by kink, volvulus, intussusception or torsion; peritonitis; or hemorrhage by sloughing of a blood vessel.

The patient concerned in this report made an uneventful recovery.—Angus K. Wilson.

EDMONDSON, HUGH A., and BERNE, CLARENCE J. Calcium changes in acute pancreatic necrosis. *Surg., Gynec. & Obst.*, Sept., 1944, 79, 240-244.

Langerhans showed that the lesions of fat necrosis consisted of calcium soaps resulting from the enzymatic effect on natural fats. He further showed that the glycerol by-product was absorbed without recognizable effect. It would seem that systemic effects might follow the dislocation of large amounts of calcium from the blood stream into the areas of fat necrosis.

The observation of a patient with fatal acute pancreatic necrosis in whom tetany existed with normal blood carbon dioxide combining power led to quantitative determinations of blood and tissue calciums which furnish the data upon which this report is based.

Materials and Methods. In the study a group of patients seen at the Los Angeles County Hospital was utilized. Three phases of study were carried out: (1) The total amount of calcium deposited in and around the pancreas in patients upon whom necropsy was done following death from acute pancreatic necrosis was estimated. (2) Measurements of the total blood calcium on patients with acute pancreatic necrosis were made. (3) Measurements of diffusible and nondiffusible calcium in patients who were known to have lowered total serum calcium were made.

Analysis of Study.

1. The amount of dislocated calcium found in and around the pancreas in 6 fatal cases of

acute pancreatic necrosis was found to be equal in amount to more than twice that present in the normal circulating blood.

2. The findings of low serum calcium levels in all severe cases of pancreatic necrosis would imply that the large loss into the tissues is not readily compensated for by mobilization of calcium from normal body stores.

3. The increased percentage of diffusible serum calcium appears to be compensatory to this lowering of the total serum calcium.

4. The authors have seen no severe cases of pancreatic necrosis in which the serum was not lowered. They have thus added a laboratory finding which tends to substantiate the elevations of blood and urinary diastase.

5. A number of patients with perforated duodenal ulcer were found to have high blood amylase levels and lowered serum calciums. These changes are physiologically consistent since fat necrosis may also be present in perforated duodenal ulcer.

6. Those patients whose serum levels were between 7 and 8 mg. per 100 cc. of serum invariably presented a very severe form of the disease. Such an index of tissue injury may furnish a basis for establishing the diagnosis of acute pancreatic necrosis as distinguished from the so-called acute pancreatic edema. Prognostic importance of the serum calcium level is indicated by the fact that death occurred in all patients in this group whose serum calcium level fell below 7 mg. per 100 cc.

7. The amount of diffusible serum calcium tends to remain stable in the presence of a decrease in total serum calcium.—*Mary Frances Vastine*.

KOHN, SCHUYLER G., BRIELE, HENRY A., and DOUGLASS, LOUIS H. Volvulus complicating pregnancy. *Am. J. Obst. & Gynec.*, Sept., 1944, 48, 398-404.

Volvulus occurring with pregnancy is a very interesting and a very rare complication. There have been only 6 cases reported in the United States and 73 cases reported abroad. The authors have studied 18 cases of volvulus complicating pregnancy including 2 original cases. They make the following observations:

The etiology of this complication (volvulus) is not clear and the only relatively consistent pathologic finding is an elongated mesocolon in those cases involving the sigmoid colon.

In all the cases reported the site of the volvulus was as follows: (1) small intestine—19

cases, (2) large intestine other than sigmoid—19 cases, (3) sigmoid—41 cases.

The diagnosis of volvulus is very difficult but intestinal obstruction is usually quite apparent.

The symptoms are those of obstruction depending upon the location of the blockage.

The prognosis for mother and child is good if early diagnosis and treatment are available.

The treatment is surgical relief of the obstructing volvulus. Termination of pregnancy does not appear to be indicated.

It would seem that large doses of corpus luteum substance pre- and postoperatively are of considerable help in allaying the sensitivity of the uterus in the first and second trimesters, when laparotomy is done, but of doubtful value in the third trimester.—*Mary Frances Vastine*.

YATER, WALLACE M., and COE, FRED O. Ten years' experience with thorotrast hepatosplenography. *Ann. Int. Med.*, March, 1943, 18, 350-366.

In a review of the literature the authors find that in recent years a large number of articles have appeared in the medical literature condemning the parenteral use of thorotrast because of supposed latent radioactivity or because of neoplastogenic properties of thorotrast deposited in the subcutaneous tissues. Practically all of these reports are based upon animal experimentation. On the other hand, no reports by clinicians have been found showing any serious ill effects as the result of the use of thorotrast. The following technique was used. The average dose employed has been 75 cc., given intravenously, usually in divided doses of 25 cc. on each of three successive days, the roentgenogram being made on the fourth day. However, the entire amount may be given at one time without danger and good roentgenograms may be obtained as early as one and three-fourths hours later.

Two hundred and eighty-six cases were examined by this method over a period of more than ten years. Of these patients 10 were known to have lived for more than ten years, 5 between nine and ten years, 3 between eight and nine years, 5 between seven and eight years, 3 between six and seven years, 4 between five and six years, 6 between four and five years, 10 between three and four years, 10 between two and three years and 12 between one and two years. No immediate or remote ill effects of importance have been observed. There has been no evidence of latent radioactivity, depression of

hepatic or splenic or hematopoietic function, lowered resistance to infection, or development of malignant neoplasia at the site of injection.

Hepatosplenography is said to be of definite value (1) in helping to diagnose cirrhosis of the liver; (2) to determine the presence of metastasis to the liver; (3) in the diagnosis of abscess of the liver.

The authors warn that care should be taken to inject thorotrast into the veins and not into the adjacent tissues, not because of the possibility of development of neoplasm but in order to prevent the formation of nodules and to save the vein.—*J. J. McCort.*

BEST, R. RUSSELL. The incidence of liver stones associated with cholelithiasis and its clinical significance. *Surg., Gynec. & Obst.*, April, 1944, 78, 425-428.

The incidence of cholelithiasis in adults is probably between 20 and 30 per cent. The high incidence of common duct stones in cases of cholelithiasis has been fully appreciated only during the last fifteen years. In the past, continued or recurrent biliary distress following cholecystectomy has too frequently been attributed to liver dysfunction, hepatitis, cholangitis, pancreatitis, or partial injury to the common duct, when as a matter of fact it was due to a stone in the common duct. It is estimated that in 1 of every 4 or 5 cases of cholelithiasis stones will be found in the common duct.

The author believes that sooner or later every surgeon will encounter one or more cases in which he feels satisfied in his own mind that the common duct has been thoroughly explored and all stones and debris removed, only to find that later, at a necessary secondary operation, another stone is present. There is no doubt that there are elusive stones in the common duct, especially at the lower end where at times they seem to seek a small diverticulum and avoid the exploring forceps, probe or irrigator. Again, stones may form from minute particles of debris or precipitate in the choledochus. However, the writer believes that another definite source of so-called recurrent or remaining common duct stones is hepatic. These stones are present in the liver at the time of the original operation and, for one reason or another, become dislodged from the intrahepatic ducts following cholecystectomy.

In 30 cases of cholelithiasis, the liver was sliced thin enough so that all intrahepatic ducts

were opened and any stone resting in a duct could be identified. In 2 of these cadavers, stones were found within the intrahepatic ducts. The literature on this subject was then reviewed and it is concluded that the average incidence of liver stones, together with cholelithiasis, is 7.4 per cent. It is suggested that the three day biliary flush be given to all patients before any biliary tract operation in the hope of flushing these liver stones into the common duct where they will be accessible at the first operation, thereby avoiding the second.—*Mary Frances Vastine.*

GYNECOLOGY AND OBSTETRICS

HARTLEY, J. BLAIR. The future of radiology in obstetrics. *Brit. J. Radiol.*, Aug., 1944, 17, 241-246.

There are a number of fields in which accuracy may be reasonably expected in roentgen examination in pregnancy, such as demonstration of fetal parts at sixteen weeks or more, estimation of fetal maturity, demonstration of fetal death, presentation and position of fetus, demonstration of bony pelvis, pelvimetry, size and shape of uterus, and detection of fetal deformities. In another group the report may be accurate but incomplete, as in detection of fetus, estimation of disproportion, diagnosis of extrauterine pregnancy, diagnosis of associated tumor and pregnancy, cause of non-descent of fetal head into pelvic inlet, demonstration of placental site, diagnosis of post-maturity and diagnosis of minor fetal defects and deformities.

Even greater usefulness is to be expected from roentgenology in the future, however, with the development of improved apparatus and technique. Relatively unexplored fields that should be studied are a study of the exact mechanism of labor, estimation of moulding, study of laws of heredity by examining cases of craniolacunia, craniostenosis, hydrocephalus, anencephaly, spina bifida and other abnormalities. These records should be followed through several generations. It should also be possible to study the causes and significance of hydrocephalus and hydramnion, to identify the site of the placenta accurately before birth and to study the normal development of the skull bones, particularly those of the vault. Mass roentgenography of primiparae and even of infants may prove valuable.

The author advocates the establishment of a National Institute for the study of obstetrics and heredity in which obstetricians and roent-

genologists shall cooperate closely, not only in examining individual cases but in keeping records over generations of the obstetrical history of families. There should be what he calls an outer ring for routine examinations and an inner ring for research teaching. He thinks a great deal could be accomplished in improving public health in this way.—*Audrey G. Morgan.*

HASTINGS, W. H. Precise pelvimetry. *Brit. J. Radiol.*, Aug., 1944, 17, 259-260.

A method of pelvimetry was described in this journal in April, 1942, p. 114, which seems to have proved successful. In this article a table of reduction factors is given which will be a useful supplement to it when the tube-shift is 3 inches.

The important measurement in square measure of the inlet is quickly made by multiplying the product of the transverse and obstetrical conjugate diameters (measured in inches) by 5 and adding 1.5 which gives the measurement in square centimeters. For the outlet the measurements of the pubosacral and bi-ischial diameters are used. A form of report of the different measurements taken is given.—*Audrey G. Morgan.*

WILLIAMS, E. ROHAN. Venous intravasation during utero-salpingography. *Brit. J. Radiol.*, Jan., 1944, 17, 13-17.

During uterosalpingography iodized oil may enter the uterine venous sinuses and pass into the uterine veins in the broad ligaments. Several such cases have been reported and while as a rule the results are not serious, 1 or 2 cases of death from oil embolism have been reported. Therefore care should be taken to prevent this occurrence.

This venous intravasation may be caused by direct injury to the uterine mucosa by the tip of the cannula, by injection at excessively high pressure, by injection when the endometrium is physiologically deficient as it is during menstruation and for six to eight days thereafter and by injection soon after surgical trauma such as curettage or dilatation of the cervix.

The author describes and gives roentgenograms of 5 cases, in 4 of which the injection was given before post-menstrual regeneration was complete and in 1 immediately after a dilatation. After the paper was written he saw a sixth case in which salpingography was performed on the seventh day after a curettage.

To prevent this accident uterosalpingography should not be performed until at least eight days after the end of the menstrual period, until full regeneration after curettage nor immediately after dilatation of the cervix. The author usually practices a fractional injection technique under screen control and under these circumstances a slight degree of intravasation may be seen as a fine network confined within the walls of the uterus.—*Audrey G. Morgan.*

BRODY, SAMUEL. Postmenopausal ovarian carcinoma. *Am. J. Obst. & Gynec.*, Sept., 1944, 48, 417-421.

The "silent" ovarian tumor has long been recognized as a great menace in the control of cancer by early recognition and treatment. The new growth is either discovered accidentally, in the course of a routine pelvic examination, or when the tumor becomes extensive enough to be noticed by the patient or to cause pressure symptoms, at which time it is usually beyond surgical interference.

The fact that a patient has received radium treatment for benign menopausal bleeding does not insure her against the development of other pelvic pathology even in the absence of bleeding. In order to further emphasize this point a case is reported. This patient, a fifty-six year old white female, received radium for uterine bleeding in 1941. The diagnostic curettage showed no evidence of malignancy. The patient was seen again in 1944 because she was complaining of pain in the abdomen. A laparotomy was done and bilateral papillary cystadenocarcinoma of the ovaries was found.

The castrating dose of radium (1,950 millicurie-hours) which was given to the patient in order to suppress the activity of the ovaries and secondarily eliminate their proliferating influence upon the endometrium, had its desired effect. This is evidenced by the atrophy and almost complete absence of the endometrium as shown in the specimen removed, and by the cessation of bleeding, clinically.

However, the irradiation had no inhibiting effect upon the later development of a neoplasm in these ovaries.

It is important to bear in mind the possibility of such a consequence in a postmenopausal patient who has received radium treatment for bleeding and is apparently cured. Such patients, as well as others under observation, should be examined at frequent regular intervals for any pelvic pathology.—*Mary Frances Pastine.*

MCGOLDRICK, JOSEPH L., and LAPP, WARREN A. Theca-cell tumors of the ovary. *Am. J. Obst. & Gynec.*, Sept., 1944, 48, 409-416.

Although fibromatous ovarian tumors associated with menstrual irregularities of postmenopausal bleeding had been reported previously in the scientific literature, it was not until 1932 when Loeffler and Priesel presented 6 cases of "fibroma theca cellulare xanthomatodes ovarii" that gynecologists and pathologists recognized a new clinical entity. To date, a total of approximately 82 such tumors have been reported in the world literature.

Histogenesis. There are two views as to the origin of the theca-cell tumor: (1) Embryonic ovarian mesenchyme (having a common origin with the granulosa-cell tumor). (2) Unused and immature theca cells of the ovarian parenchyma (and therefore a separate entity from the granulosa-cell tumor).

Clinical Features. Sixty-five per cent of theca-cell tumors occur after the menopause and 35 per cent occur in the period between puberty and the climacterium. The tumor has never yet been demonstrated in children.

If the tumor occurs during the years of normal sexual activity there may be menorrhagia often preceded or succeeded by a period of hypomenorrhea or amenorrhea. Sometimes there are no menstrual irregularities. Varying degrees of virilism have been reported in 3 instances.

Atypical bleeding is the most prominent symptom in postmenopausal patients. Other changes noted are a rejuvenation of atrophic breast tissue, recrudescence of libido, and a revitalization of the vaginal mucosa.

Physiologically, because of the hyperestrinism produced by the tumor, the uterus becomes enlarged and softened, with a glandular cystic or adenomatoid hyperplasia of the endometrium.

Pathology. The tumor is always unilateral. Thecoma tends to simulate fibroma of the ovary in size, shape and consistency. A capsule is commonly present. On cut section, the surface is seen to be composed of varying-sized islands having a diagnostic yellow hue and separated by grayish-white fibrous bands. Small cystic areas are an inconstant feature and result from liquefaction necrosis. Histopathologically, the tumor is composed of interlacing fasciculi of connective tissue scattered through which are nests of polygonal or large spindle cells having an epithelioid appearance.

Treatment. At the most, theca-cell tumors are a form of low grade ovarian malignancy. Most surgeons feel that treatment need not be radical, a simple excision of the ovary being sufficient in the vast majority of cases. Theca cells are considered to be radioresistant, so that radiation therapy is generally considered to be of little or no value except for the diminution of the size of the tumor by the effect of roentgen radiation on the fibrous tissue stromal elements.

Summary. The authors have reported 4 additional examples of theca-cell tumors of the ovary. All the tumors were benign. One very large tumor occurred in a seventeen year old girl, producing no menstrual irregularities. One tumor associated with a fibroma of the opposite ovary showed infarction due to torsion of its pedicle.—*Mary Frances Vastine.*

GENITOURINARY SYSTEM

NATION, EARL F. Renal agenesis; study of thirty cases. *Surg., Gynec. & Obst.*, Aug., 1944, 79, 175-181.

Definition. Agenesis denotes the complete lack of development of the metanephros on one or both sides. The presence of a vestige of renal tissue should classify a case as one of aplasia, not agenesis.

Another differentiation that must be made is between the absence of a kidney on one side due to agenesis and that due to crossed ectopia. If there is evidence that the kidney tissue present on only one side developed from the renal blastema of both sides the condition is one of crossed ectopia, not of unilateral agenesis. In such a case there will be a ureter opening into each side of the trigone.

Embryology. The kidney is formed from a cap of mesoderm, the metanephric blastema, about the ureteral bud. The differentiation of this nephrogenic blastema begins with the growth of the ureteral bud into it. The latter sprouts from the dorsal surface of the wolffian duct near the cloaca during the fourth week of retal growth.

Etiology. The fundamental cause of renal agenesis is probably to be found, in most cases, in defective germ plasm. The complete absence of the ureter in most cases of renal agenesis indicates that the usual cause of agenesis is faulty development of the urinary organs which precede the ureteral bud. The absence of the suprarenal gland on the same side as the kidney is not a necessary concomitant for the diagnosis of renal agenesis.

Analysis and Discussion of Unilateral Agnesia.

1. Sex. There were 18 (67 per cent) males and 9 (33 per cent) females. In the Los Angeles County Hospital autopsies, unilateral and renal agnesia was approximately 20 per cent more common in men than in women.

2. Race. All reported here were Caucasian.

3. Age. There were no significant age distributions for the autopsy cases except for a considerably higher death rate under one year of age. The youth of the patients of the clinical series indicates a tendency for urinary tract pathology, or of the concomitant congenital abnormalities, to make themselves known early in life.

4. Urinary tract. The right kidney was absent in 14 cases and the left in 13. The ureter and the corresponding half of the trigone were totally absent on the side of the renal agnesia in 21 cases (77 per cent). The solitary kidney was enlarged in all but 4 cases.

In 11 cases (41 per cent) there were congenital abnormalities of the solitary kidney or ureter. There were 3 instances of partial duplication of the ureter.

In 3 (19 per cent) of the autopsy cases, besides the 3 with aplastic solitary kidneys, the cause of death was renal failure: 2 renal tuberculosis and 1 chronic glomerulonephritis.

In 6 cases (22 per cent) there were developmental defects of the genital organs.

There is little hope of distinguishing renal agnesia from renal aplasia clinically with any degree of certainty. Absence of one-half of the trigone is much more indicative of agnesia than of aplasia. Absence of one ureteral orifice, or representation of the orifice by a mere dimple, or termination of the ureter just beyond the bladder wall occur more commonly with renal agnesia than with renal aplasia.

Summary.

Three cases of bilateral renal agnesia from a series of 27,000 autopsies are reported.

Twenty-seven cases of unilateral renal agnesia are reported. This number includes 6 clinical cases reported by the author.—*Mary Frances Vastine.*

HERGER, CHARLES C., and SAUER, HANS R. Cortical kidney tumor—analysis of 100 consecutive cases. *Surg., Gynec. & Obst.*, June, 1944, 78, 584-590.

During the past twenty years, 100 patients with malignant cortical tumors of the kidney

were admitted to the urological service of the New York State Institute for the Study of Malignant Diseases. Metastases or evidence of local recurrence at the time of admission were demonstrable in 53 of the cases; 23 of them underwent nephrectomy or exploratory operation elsewhere prior to admission. The object of this study is intended to analyze the material as to history, symptoms, and clinical course.

Sex and Age. Among the 100 patients, there were 65 males and 35 females. The age for these patients varied from seventeen to seventy-five years with 89 patients between forty and sixty-nine years.

Situation and Pathology. Sixty-one of the tumors originated in the right kidney and only 39 in the left kidney.

Microscopic sections were available in only 45 cases. The following types of tumor were identified: hypernephroma, 16; papillary adenocarcinoma, 24; carcinoma, 4; sarcoma, 1. Four of the 100 patients showed evidence of double primary malignant neoplasm.

Symptoms. The classic triad of symptoms—pain, hematuria, and tumor—is encountered as a rule in far advanced cases only. In this series, pain, hematuria, and tumor were present in 31 of the 100 patients. All of them had far advanced and inoperable lesions. Hematuria alone (15 cases) or in combination with pain (6 cases) or tumor and pain (31 cases) was present in 52 patients. The most favorable prognosis as to possibility of cure was offered by the group of 15 patients with painless hematuria only.

There is a certain number of cortical tumors of the kidney which, in spite of definite histopathological evidence of malignant new-growth, show very slow progress of the disease. These tumors have little tendency to perforate the kidney capsule and, if metastases develop, even the metastases have little tendency to progression. Some of these tumors may not affect the wellbeing of the patients for many years because they exert little toxic effects.

Metastases. Metastatic spread of the disease was demonstrable in 60 of these 100 patients. The organs involved in order of frequency were: lungs, 29; bones, 20; liver, 8; distant lymph nodes, 7; mediastinum, 6; vagina, 4; skin, 3; adrenals, spleen, cervix, uterus, and urethra, 1 each.

Metastases from parenchymal renal tumors are of frequent occurrence. This is largely due to the fact that kidney tumors have a tendency

to invade the renal vein even in the early stages of the disease.

Symptoms from metastatic lesions were the first indication of the presence of the tumor in 17 per cent of the 100 patients comprising this study. The fact that 10 of these 17 patients had initial symptoms due to bony metastases suggests that, in spite of the absence of symptoms pointing to the possible presence of a kidney tumor, a complete urological examination should be carried out in all patients with obviously metastatic bone lesions of unknown primary origin.

Treatment. Surgery offers the only chance of cure, provided the tumor is still operable. External radiation treatment is of little or no value in the majority of the cases because parenchymal neoplasms of the kidney are radioresistant.—*Mary Frances Vastine.*

HAAS, R. L. Genital tuberculosis in the female.

Am. J. Obst. & Gynec., July, 1944, 48, 69-74.

Data are presented on 62 cases of proved genital tuberculosis admitted to the University of Michigan Hospital during the last twenty years, with follow-up studies on all cases. The following conclusions are reached:

1. There were no clinical signs or symptoms pathognomonic of pelvic tuberculosis.
2. Sixty per cent of the patients were in the childbearing age.
3. Forty-three and one-half per cent of the married patients had not conceived.
4. One-half of the patients (51.6 per cent) revealed no evidence of active extragenital tuberculosis.
5. When operative treatment is indicated, all the genital organs including the cervix should be removed, even though the latter appears normal grossly.
6. Wound complications (infection and fistulas) are much more common after incomplete operations.
7. Seventy-four per cent of the patients in this series are alive, an average of 10.5 years after their first admittance.
8. Fifty-four per cent of the survivors claim good health with no untoward symptoms.—*Mary Frances Vastine.*

DOCKERTY, MALCOLM B., and MASSON, JAMES C. Ovarian fibromas; clinical and pathologic study of 283 cases. *Am. J. Obst. & Gynec.*, June, 1944, 47, 741-752.

Exactly two hundred years have elapsed

since Astruc in 1743 gave to the medical literature the first description of an ovarian fibroma. The author's report on ovarian fibromas is based on the study of 312 of these tumors occurring in a group of 283 patients. The following conclusions are reached:

1. Ovarian fibroma is the second commonest of the solid ovarian neoplasms. Three hundred and twelve of these tumors accounted for 5 per cent of all ovarian tumors surgically removed at the Mayo Clinic.

2. Ovarian fibroma was never encountered before the age of puberty and this observation has been taken to indicate an origin possibly based on a desmoplastic reaction to the hemorrhage of ovulation or ovarian endometriosis.

3. Ovarian fibroma did not produce any specific diagnostic symptoms.

4. Fifty-one cases had abdominal ascites and 2 cases presented hydrothorax (Meigs' syndrome) suggesting a malignant process. However, these patients never presented the picture of cachexia.

5. The complications of these tumors were chiefly those associated with twisting of the pedicle of the tumor—a phenomenon which rarely occurred until the tumor outgrew the confines of the true pelvis.

6. Pathologically, most of the tumors were solid throughout, white and usually invested by a smooth capsule free from adhesions. Many of the tumors were edematous and a number of these had undergone degenerative changes with central cysts.

7. In 90 per cent of the cases the tumor was unilateral.

8. Bilateral fibroma-like tumors sometimes proved to be metastatic tumors of the Krukenberg type with the primary neoplasm most frequently in the stomach. A yellowish color suggested theca-cell tumor, especially in cases in which the uterus was large and postmenopausal bleeding was noted clinically. In others the yellow color resulted from fatty metamorphosis. A grayish-brown color and firm consistency were noted in several tumors that later proved to be of the Brenner type. A brownish color and soft consistency indicated malignant change, which occurred in 1 per cent of the tumors studied.

9. Microscopically, both cellular and fibrous types appeared to arise from the spindle cells of the ovarian cortex with hemorrhage as a possible inciting element. Degenerative changes, such as fatty, fibrous, hyaline and calcareous,

took positions of importance secondary to the phenomenon of intercellular edema, which correlated more universally than did gross edema and formation of cysts with the clinical production of ascites.—*Mary Frances Vastine.*

NERVOUS SYSTEM

LAGOMARSINO, ENRIQUE H., and DAL LAGO, HECTOR. Las lesiones medulares en los traumatismos cervicales. (Lesions of the spinal cord in cervical trauma.) *Rev. ortop. y traumatol.*, Oct., 1943, 13, 95-106.

Traumatic lesions of the spinal cord may occur without injury of the vertebrae. Two cases are discussed in young men of nineteen who fell from a height during exercises and struck on the head with the neck in extreme flexion. Both showed quadriplegia at first; roentgen examination was negative. Complete functional restitution was brought about in one case while in the other flaccid diplegia of the arms and slight spasticity of the legs without Babinski sign or sensory phenomena persisted.

A detailed analysis is given of the mechanism of cervicocephalic hyperflexion and photographs and roentgenograms given showing the exact position of the different parts of the vertebrae in each phase of the movement. Longitudinal forces act on the cord, elongating it, and anteroposterior forces, compressing it. This may result in contusion, concussion or elongation of the cord. Hematomyelia may occur in either contusion or elongation of the cord.—*Audrey G. Morgan.*

SPURLING, R. G., and SCOVILLE, WILLIAM B., Lateral rupture of the cervical intervertebral discs. *Surg., Gynec. & Obst.*, April, 1944, 78, 300-358.

The primary purpose of this report is to call attention to the rôle of the lower cervical intervertebral discs in the production of shoulder and arm pain. The data upon which statements are based were collected from 12 verified cases of ruptured cervical discs.

Anatomy and Physiology. The cervical roots, unlike the dorsal and lumbar roots, emerge from the dura mater at right angles and lie immediately over the intervertebral discs. As a consequence, a lateral protrusion of a cervical disc may compress the nerve root against ligamentum flavum, lamina, pedicle, or facet without much damage to the spinal cord.

Pathology. Degenerative processes play an important rôle in the production of the lateral rupture of the cervical intervertebral disc. This is indicated by the frequency with which there is roentgen evidence of localized arthritic spurs and narrowing of the intervertebral disc at the site of the lesion.

Signs and Symptoms. The fifth cervical disc. (a) Pain radiating from the neck into the shoulder and arm with paresthesias (needles and pins or numbness) into the posterior aspect of the thumb. Symptoms are always aggravated by tilting the head to the painful side. (b) Weakness or absence of the tendon reflex of the biceps brachialis muscle.

The sixth cervical disc. (a) Pain radiating from the neck into the shoulder and arm with paresthesias into the index, middle, and perhaps the ring fingers and tip of thumb. Symptoms aggravated by tilting head to the painful side. (b) Weakness or absence of the tendon reflex of the triceps brachialis muscle.

Differential Diagnosis. (1) Bony lesions of the cervical spine, either neoplastic or inflammatory may cause radicular pain similar in every respect to cervical disc lesions. (2) Neoplasms of the spinal cord, particularly those arising from the nerve roots, may give identical symptoms. (3) Scalenus anticus compression, with or without cervical rib, is the lesion most easily confused with ruptured cervical discs. It is to be remembered that the nerve pain from scalenus anticus compression is ulnar in distribution while that in the cervical disc pain is of median or radial nerve distribution. (It should not be forgotten that any lesion of the cervical spine may produce spasm of the scalenus muscle. It is not uncommon, in fact, to have the clinical features of a ruptured cervical disc overshadowed by a superimposed scalenus syndrome.)

Roentgen Examination. (1) The lateral roentgenograms usually show narrowing of the interspace with loss of the normal lordotic curve even in a hyperextended position. (2) Oblique views may show narrowing of the intervertebral foramen with proliferation of bone in the foramen (osteophytes). (3) Panto-paque myelography is an exceedingly accurate method of diagnosing ruptured cervical discs.

Treatment. Conservative treatment relieves symptoms in many cases (bed rest with halter traction). When conservative measures fail, operative removal of the lesion is justified on the basis that it is a simple, safe procedure, and

the results are excellent. Of the 12 patients operated upon at the Walter Reed General Hospital, all have been relieved of their radicular pain within two weeks following operation.

Observations. (1) The cervical disc lesions occur more frequently in the upper age group. This is in contrast to the younger age group in which ruptured lumbar discs are seen. (2) Twice as many ruptured discs occur at the sixth interspace as at the fifth interspace. (3) Unlike the lumbar disc lesions, trauma does not play a prominent part in the etiology of cervical disc lesions.—*Mary Frances Vastine.*

LOVE, J. GRAFTON. The differential diagnosis of intraspinal tumors and protruded intervertebral disks and their surgical treatment. *J. Neurosurg.*, July, 1944, 1, 275-290.

From an analysis of 26 cases in which intraspinal tumors masqueraded as protruded intervertebral discs, and from his experience, Love outlines the differential diagnosis of these two conditions. Males predominate almost three to one in the disc cases while sex distribution approaches equality in cord tumor cases. No significant difference in age groups was noted in this study. Antecedent trauma in cases of protruded discs is well established; it may initiate symptoms of a cord tumor, however, Neurological signs predominate in tumor cases, while physical signs such as limitation of spine movement, limping, a positive straight leg raising test, etc., predominate in the other group. In both conditions the spinal fluid protein is elevated usually above 40 mg. per 100 cc., is rarely over 100 mg. per 100 cc. in disc cases but may be much higher with tumors averaging in this series over 1,400 mg. per 100 cc. Xanthochromic fluid is often seen with tumor cases in the presence of subarachnoid block. Pain is more often unilateral with a disc, the onset of illness more abrupt. Preliminary studies with ordinary roentgen examinations often differentiate the conditions such as the demonstration of bone erosion by tumor. A differential lumbar puncture using two needles one above and one below the tumor is helpful. About 85 per cent of protruded discs are removed by the interlaminar approach while tumors require the removal of one or more laminae. Hemostasis is of great importance in the surgical treatment of both lesions.

While Love admits the unreliability of air spinograms and acknowledges the value of

opaque myelography as a means of differentiation of these conditions, he feels that certain dangers are present in the use of non-absorbable media in the presence of elevated spinal fluid proteins. He apparently is cautious about their use. [This paper was prepared before the general availability of absorbable media and the perfection of complete aspiration techniques of spinal subarachnoid contrast media.]—*Leo A. Nash.*

SHINNERS, BURTON M., and HAMBY, WALLACE B. The results of surgical removal of protruded lumbar intervertebral discs. *J. Neurosurg.*, March, 1944, 1, 117-122.

In the period from 1937 to July, 1943, 127 examples of protruded intervertebral discs were found in 140 patients at 160 operations including those with multiple lesions and recurrences. In 91 of the 140 patients, 100 spinograms were done using lipiodol, air or thorotrast. Of these, 69 per cent were proved correct, 20 per cent were false positives and 11 per cent were false negatives. In the last few months of this study, spinograms were almost completely abandoned. In the series a progressively smaller exposure was made down to an interlaminar approach and the later cases had tantalum powder implanted in the disc sinus as a signal for possible recurrence. In 116 patients with protruded discs, 13 fusions of the spine were done if instability of the back was present as determined by orthopedic consultation. Of 87 cases traced, 49.5 per cent considered themselves cured, 48.3 per cent improved and 2 cases thought themselves to be worse. Of 7 patients fused and traced, 5 were free of pain and working and 2 did not reply to that portion of the question form submitted. Of 5 not relieved by disc operation and who were later fused, 3 obtained relief. Fifty-four per cent of all cases had residual back or leg pain and 57.3 per cent had back or leg pain while working. The subjective results of private cases and compensation cases correlated very highly except that the former returned to work earlier. Ninety-two per cent were glad they had had the operation.—*Leo A. Nash.*

SKELETAL SYSTEM

DOEL, GEOFFREY. Further notes on the structure and function of the intervertebral disc. *Brit. J. Radiol.*, Aug., 1944, 17, 255-256.

The author has been making a study of the

intervertebral disc based on anatomical, physiological and mechanical data. He is in disagreement with some of Schmorl's findings, especially his claim that the nucleus pulposus has the quality of turgor, that is ability to increase its own volume. Ffrancon Roberts has refuted this theory but he claims that the annulus fibrosus has the property of tonus. This is equally false. The annulus has no muscular or nervous elements and therefore it cannot possess tonus. No forces are produced inside the joint. The pressure within the disc which keeps the joint apart and which sometimes extrudes the pulpy nucleus is produced by external forces, including the tonus of the paravertebral muscles, the weight of the body tissues in the erect position and atmospheric pressure acting through the whole body.—*Audrey G. Morgan.*

PECK, FRANKLIN B., and SAGE, CHARLES V. Diabetes mellitus associated with Albright's syndrome (osteitis fibrosa disseminata, areas of skin pigmentation, and endocrine dysfunction with precocious puberty in females). *Am. J. M. Sc.*, July, 1944, 208, 35-45.

This is a report of a case of diabetes mellitus associated with Albright's disease. There have been no previous cases reported in the literature and in the group of cases collected by Dr. Albright, numbering more than 50, no association with diabetes was noted. It is of interest that in this case the roentgenograms of the skull are suggestive of osteitis deformans, as these cases are frequently seen to exhibit abnormal glucose tolerance curves. Albright has stated that the roentgen examination presents three features which distinguish this disease from hyperparathyroidism: (1) there are areas of increased density and overgrowth of bone as well as decreased density; (2) the condition is not generalized and one should be able to find parts of the skeleton which are perfectly normal; (3) the disease practically never involves the epiphyses. No etiological conclusions were drawn by the author on this one case since diabetes develops in one of 200 to 250 persons in the population and there is a history of diabetes in the patient's family.

A twenty-two year old white male was admitted with diabetes and coma. There were brownish pigmented areas on the skin. On admission he had acute sinusitis, facial cellulitis and pyorrhea alveolaris. Exophthalmos of a moderate grade was observed after recovery

from coma and a smoothly palpable thyroid. Roentgen rays of the head, chest, pelvis and left leg disclosed marked enlargement of the middle and outer tables of the skull. The frontal sinuses and maxillary sinuses were obliterated and the jaw was prominent. The pelvis showed marked cystic appearing areas as well as dense irregular striations and marked cox vara. The femurs and left tibia also showed the same pathologic changes but to a lesser degree.

This patient showed severe diabetes and finally coma, together with enlargement of the mandible, as demonstrated by roentgen ray which was suggestive clinically of acromegaly. In addition there was exophthalmos, elevated basal metabolic rate and goiter which pointed toward the pituitary as a factor. This was supported by the insulin tolerance curve and, in addition, the lack of responsiveness to hypoglycemia suggested adrenal involvement. It is pointed out that precocious puberty in females having the disease cannot be directly attributed to pituitary tumors. Hypothalamic lesions are known to produce this type of precocious puberty. Study of this case, therefore, suggests a complex endocrine disturbance, possibly originating before birth and implicating the pituitary gland.—*James J. McCort.*

TAYLOR, HENRY K. Aseptic necrosis in adults; caisson workers and others. *Radiology*, June, 1944, 42, 550-469.

Roentgen examination of individuals who have worked in compressed air sometimes shows single or multiple infarcts in the shafts of long bones, with or without areas of aseptic necrosis in the joints. The disease caused by too sudden release from pressure after working in compressed air is variously described as caisson disease, aero-embolism or bends. The injury is caused by nitrogen bubbles liberated when the body is removed too rapidly from the compression chamber. Aero-embolism has been reported in aviators and deep-sea divers but they have not shown bone or joint changes.

But similar changes may be seen in the bones and joints of individuals who have never worked in compressed air. The author discusses 54 patients seen by him who had aseptic necrosis and bone infarcts; 13 of these were women. Of the 41 men, 12 had a history of continued exposure to compressed air, 1 a history of a single exposure and the rest no occupational history. Of the 13 patients who had worked under compressed air, some had

been subjected to sudden changes of pressure and had had symptoms of aero-embolism or bends. Others had not been subjected to sudden changes in pressure; some of these had had mild symptoms of decompression sickness and some did not.

Lesions of the bones and joints do not develop until some time after decompression. The bone lesions are generally asymptomatic; secondary arthritic changes resembling those of chronic hypertrophic osteoarthritis develop in the joints.

The lesions seen in the non-occupational group were the same as those in the occupational group and could not be differentiated roentgenologically. Illustrative roentgenograms are given. One of the cases of aseptic necrosis was in a patient who had sickle cell anemia and a history of polyarthritis. The etiology of the non-occupational cases is not known.

The bone lesions are generally multiple and often bilateral. They are more frequently extensive and multiple in caisson workers than in others. The reparative changes are generally greater in the non-occupational group.—*Audrey G. Morgan.*

DICKISON, J. C., and SHANNON, J. G. Fractures of the carpal scaphoid in the Canadian army. *Surg., Gynec. & Obst.*, Sept., 1944, 79, 225-239.

This presentation is the result of a study of 257 cases of fractured carpal scaphoids occurring in a period of approximately three years in the Canadian Army Overseas.

Analysis of Study. The results of treatment in those cases diagnosed early are quite satisfactory; in the cases not diagnosed early the results of treatment leave much to be desired.

The results achieved in the treatment of the simple fresh waist fractures are excellent. Union occurred in all these cases. If such fractures are immediately immobilized and kept so for a sufficient length of time they will unite.

The problem does not lie in the treatment, but rather in the diagnosis—indeed, the major problems from fractured scaphoids arise from failure to make an early diagnosis. A fractured scaphoid may be suspected from clinical examination, but the diagnosis can be positively established or excluded only by roentgenograms. The latter must be taken in the anteroposterior, lateral and oblique positions. The oblique is the most important view. Im-

mediately after injury it is often difficult to establish the diagnosis roentgenographically. Only a very faint fracture line may be seen. The diagnosis of sprained wrist should be made with the greatest of caution, and only after fracture of the scaphoid has been positively excluded by repeated roentgenographic examinations.

Displacement is a rare but serious complication and must be corrected. It may be a lateral deviation, a distraction of the fragments or an angulation, this last usually being a widening of the radial side of the fracture line.

When the proximal pole fractures which were diagnosed early are examined, three points stand out: (1) there were only 12 of these as compared with 125 waist fractures; (2) the average time required for union was twenty weeks, whereas in the waist fractures it was twelve weeks; (3) delayed union and non-union occurred relatively much more often in this group than in the waist fractures. In fractures of the proximal pole vascular disturbances are more common and frequently there is complete severance of the blood supply leading to the proximal fragment so that avascular necrosis occurs in this part of the bone. Avascular necrosis is not necessarily a precursor of non-union—it only delays union. Revascularization of the proximal fragment with subsequent union of the fracture may take place.

There were 70 cases in this series of 247 cases which were not diagnosed until at least two months after the injury. Twenty-seven patients in this group with late diagnoses were treated by immobilization, but in only 6 of these did union occur. No fracture united in which the diagnosis was made later than nine months after injury.

In the fractures that united following operation, fourteen weeks is the shortest period of immobilization; while in those that did not unite the plaster was often removed in less than fourteen weeks.

There is only one proved indication for the use of operation, and that is established non-union—sclerosis of the fracture margins. The technical difficulties of the operation are great, and it should be undertaken only after most serious consideration.

Whether or not multiple drill holes will hasten the revascularization of the fragment in which there is avascular necrosis and thus hasten the process of union cannot be determined from this study.

It is probably true that a fractured scaphoid never unites if left untreated.

Complete or partial excision is of no use in these fractures.

As has been said, the period required for healing in any fractured scaphoid may be very long.—*Mary Frances Vastine.*

MACAUSLAND, W. RUSSELL. Perilunar dislocation of the carpal bones and dislocation of the lunate bone. *Surg., Gynec. & Obst.*, Sept., 1944, 79, 256-266.

The purpose of this paper is three-fold: (1) to emphasize again the importance of early diagnosis and treatment of dislocations that concern the lunate bone; (2) to describe in simple form the dislocations that concern the lunate bone; and (3) to present the observations and results in a series of 24 cases.

Types of Dislocation. The first type is the perilunar dislocation of the carpus in which the distal row of carpal bones is displaced around the lunate bone, while the latter retains its normal or practically normal relationship with the radius. The dislocation is usually upward and backward, and may be complicated by a fracture of the navicular bone or of a styloid process, although a perilunar dislocation toward the volar aspect is not unknown.

The second type is a dislocation of the lunate bone itself, usually volarward. When dislocated volarward, the lunate bone may be found to have pivoted on the intact volar radiocarpal ligament so that it lies rotated, usually about 90 degrees. In severe cases in which the volar radiocarpal ligament also is ruptured, the lunate may lie entirely free in the soft tissue in front of the forearm bones.

Mechanism. The generally accepted theory of the mechanism of both types of dislocation is as follows: A person falls on the outstretched hand, forcibly hyperextending the wrist. The distal row of carpal bones rides upwards and backwards. No true rotation of the lunate bone takes place because of the intact dorsal ligament and

capsule. Thus the perilunar type of dislocation is produced. When the capitate bone (in the distal row of carpal bones) in its backward course is forced against the radial margin, the dorsal radiocarpal ligament is torn and the lunate bone is squeezed out of the socket. Thus the lunate type of dislocation is produced.

In the usual dorsal dislocation of the lunate bone, the mechanism is the reverse of that in volar dislocations. The injury is one of forcible hyperflexion of the hand.

Occurrence. These dislocations, although among the more common carpal injuries are not of frequent occurrence. Over a period of twenty-seven years, only 24 cases have come to the author's attention.

Clinical Features and Diagnosis. (1) History of fall on outstretched hand; (2) a prominence on anterior surface of the wrist; (3) fingers held in slight flexion; (4) wrist motion limited in flexion and fingers cannot be fully extended; (5) damage to median nerve indicated by tingling sensation, paresthesia or excruciating pain; (6) palpation of dislocated lunate bone under flexor tendons of the wrist; (7) if there is associated fracture of the navicular bone, pressure in the anatomical snuff-box elicits tenderness; (8) in dorsal or palmar perilunar dislocation of the carpal bones, a prominent ridge is palpated on the outer or under surface of the hand as the case may be.

The ultimate diagnosis lies with the roentgenogram. A true lateral view is needed to demonstrate the dislocated bone or bones and anteroposterior views to reveal any associated fractures.

Treatment. Early manipulative treatment gives excellent results. Excision of the lunate bone, on the whole, results in a useful wrist and hand. The author recommends operative reduction in uncomplicated dislocations of the lunate bone when manipulation fails or when the case is treated within six weeks of the injury. Dislocations of the lunate of more than six weeks' standing are best treated by operative excision.—*Mary Frances Vastine.*

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ROENTGENOLOGICAL MANIFESTATIONS OF PRIMARY PULMONARY COCCIDIOIDOMYCOSIS*

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THE purpose of this presentation is to consider the characteristic roentgen features as observed in a study of 60 cases of primary coccidioidomycosis. Twelve cases, which demonstrated a severe and extensive form of pulmonary involvement, are particularly emphasized.

HISTORICAL AND CLINICAL BACKGROUND

Coccidioidal granuloma has been known as a chronic mycotic infection since the original descriptions by Posadas and Wernicke¹² in South America (1892), Rixford⁹ in California (1894) and Ophüls and Moffit⁷ (1900). About 744 cases¹⁰ of this disease have been reported up to 1942. Dickson⁴ in 1937 suggested the term "coccidioidomycosis" for this condition and called attention to an initial or primary stage, which he identified as being similar to an illness observed in the San Joaquin Valley of California and there known as "valley fever" or "desert fever." He further differentiated this early phase from the granulomatous or secondary stage of this disease.

The mode of infection is usually by in-

halation of the chlamydospores of the fungus, *Coccidioides immitis*. This organism, which is endemic primarily in California and to a lesser extent in Arizona and Texas, consists fundamentally of two forms: a vegetative phase which exists in nature, and a parasitic spore which is found in the tissues of the host. The organism is not transmissible from man to man.

Clinically, primary coccidioidomycosis is manifest as an upper respiratory or mild bronchopneumonic illness with cough, chest pain, fever, erythema nodosum and positive pulmonary roentgen findings. After a mild and self-limited course over a period of three to six weeks, the patient usually makes a complete recovery.

In some cases the secondary stage of the disease follows. This can be protracted over many years with severe localizing skin and bone lesions or it can be rapidly fulminating in character, with a course of but a few weeks and with a terminal miliary or meningeal picture. The mortality in the chronic stage is estimated at about 50 per cent as compared to the negligible death rate in the initial stage.

* Analysis of Pathological Features by Captain W. B. Chamberlin, Jr., Medical Corps, Army of the United States.

The relation between the primary and secondary forms is considered to depend chiefly on the effects established within the host by a potent invading organism, as countered by the reaction of a constitutional and natural immunity. In instances where the inherent resistance is low, as among individuals entering an endemic area for the first time, or as among the dark-skinned races (prominent examples of which are the Negro, Mexican and Filipino) progress to the granulomatous stage may follow by a metastatic and hematogenous spread from the primary (usually) pulmonary focus.

When the primary infection becomes well walled off by the host,¹¹ the only residual evidence may be a positive coccidioidin skin test. This skin test is an allergic manifestation which is usually established about four weeks following exposure to the organism—and remains so for a fairly long period of time; in the San Joaquin Valley this duration has been estimated as about twenty years. Once a patient is allergized, an external reinfection does not occur. When coccidioidial granuloma follows, it does so only as an endogenous reinfection.

Diagnosis of this disease is usually determined by a consideration of the following: a history of exposure in an endemic area, clinical manifestations including erythema nodosum and eosinophilia, associated roentgenologic features, positive coccidioidin (1:100) skin test, positive complement fixation and precipitin tests.* Final diagnosis can be based only on the isolation of the spores from sputum by culture.

ROENTGENOLOGICAL BACKGROUND

The pulmonary manifestations of primary coccidioidomycosis have become roentgenologically significant within recent years. Reports by Carter,² Powers and Starks,⁸ Winn,¹³ Colburn,³ Farness,⁵ Schultze,¹⁰ and Smith,¹¹ indicate that this

disease produces a fairly well defined and consistent roentgen pattern, which, together with the history of exposure and the clinical features, permits early consideration of this configuration as a diagnostic roentgen entity.

Carter describes peribronchial thickening and mottling, partial and complete consolidation, mediastinal and hilar lymphadenopathy, pleural involvement and cavitation. In the secondary or granulomatous stage, he noted pulmonary appearances similar to those seen in the primary stage. These apparently represented progress of the lesions to chronicity. In addition, a mediastinal mass was noted in 50 per cent of cases and miliary pulmonary dissemination in over 30 per cent. The characteristic features of the secondary stage were the association of extrapulmonary manifestations. In 50 cases, Carter recorded ninety destructive bone lesions.

Powers and Starks have observed solitary lesions and bilateral nodular infiltrations. These latter went on to cavity formations which subsequently cleared. Hilar adenopathy was not prominent in their series. Winn described 13 cases of cavity formation in this disease.

Farness described an acute miliary process, similar to miliary tuberculosis, in a twenty-three year old female. This patient, shortly after childbirth, developed high and septic fever. Roentgen examination showed a fine, diffuse, infiltrative process bilaterally. Two weeks later, both lungs showed miliary seedings. On autopsy, coccidioidial spherules were recovered from the lungs. This overwhelming type of infection is of clinical and roentgenological importance, since it demonstrates how a poor resistance to this disease may produce an extensive primary pulmonary involvement which may be closely followed by a miliary disseminated coccidioidial process.

ANALYSIS OF CASES: ROENTGENOLOGICAL CLASSIFICATION

All of our patients were Army personnel from the Southern California and Arizona

* The complement fixation and precipitin tests in most of the cases in this series were done by Dr. C. E. Smith, Stanford University Medical School; the remainder (precipitin tests only) by an Army medical laboratory.

Desert areas. The greatest number had never previously lived in or travelled through these regions. Twenty-five (41.6 per cent) were Negroes; 1 patient was Indian and 1 was Mexican. The remainder (45 per cent) were white. There were 2 females in this series. Forty-seven (78 per cent) were in the third decade.

Of the clinical and laboratory manifestations, cough, chest pain and fever were present in 75 per cent of cases; erythema nodosum in 30 per cent; eosinophilia in 25 per cent. Positive coccidioidin skin test (1:100) was present in 80 per cent; positive serology (complement fixation and precipitin tests) in 86 per cent. In 6.6 per cent the sputum was positive for endospores.

Positive roentgen findings were found in 85 per cent of cases. The pulmonary features permitted the following classification:

- | | |
|--|---------|
| (1) <i>The Nodular Lesion</i> | |
| a. Single or multiple | 22% |
| b. Unilateral or bilateral | |
| (2) <i>Peribronchial Infiltration</i> | 22.5% |
| a. Without marked hilar enlargement | (6%) |
| b. With associated hilar adenitis | (16.5%) |
| (3) <i>Confluent Consolidations</i> | |
| a. Moderate or extensive. | 20% |
| b. Bronchopneumonic or lobar | |
| (4) <i>Hilar Lymphadenopathy</i> | 24.5% |
| a. With slight peribronchial infiltration | (8%) |
| b. With marked peribronchial infiltration | (16.5%) |
| (5) <i>Pleural Involvement</i> | |
| a. Pleural effusion | 5% |
| b. Adhesive pleuritis | |
| (6) <i>Cavity Formation</i> | 5% |
| (7) <i>Bilateral Nodular (Local) Dissemination</i> | 20% |
- (Note: 2b and 4b are identical groups)

The Nodular Lesion. So called because of the presence of an isolated and spherical shadow as the most prominent feature on roentgen examination. Microscopically, this structure closely resembles a tubercle. Coccidioidal spores are usually seen in a focal area of necrosis. Giant cells, mononuclear cells and granulation tissue are located peripherally. This nodular lesion was noted in 22 per cent of cases. The nodule is commonly seen at the apex, base, or the periphery of the pulmonary field. It may be unilateral or bilateral (Fig. 1); it

may be of slight density or may stand out firmly and prominently. The borders of the nodule may be hazy and irregular because of peripheral inflammatory reaction or may be sharply delimited because of early fibrosis. The size may vary from 5 mm. to 2.5 cm. in diameter. The nodule may clear rapidly and completely within a few weeks or may persist for many months. In this latter form, the lesion may contract only partially form a firm fibrous capsule and persist as an incompletely resolved focus. None of the nodules in this series underwent cavity formation. No calcifications were noted, but these cases were followed for only a limited period of time. When the nodule appears in the upper lobes, reinfection tuberculosis must be differentiated. Pulmonary carcinoma of the alveolar or of the secondary metastatic types, neurofibroma and ganglion neuroma, neoplasm from the chest wall and pleura reflected onto the pulmonary fields may all produce similar appearances. The inflammatory nodules will show rapid change, variation in density and the association of fibrosis. The tumors will frequently have a lobulated outline, may show no change on serial study. The neurofibroma will be located posteriorly in the lateral view.

Peribronchial Infiltration. Subsequent to the parenchymal nodal implant, a productive type cellular inflammatory reaction takes place in the peribronchial and perivascular lymphatic and interstitial tissues. This is shown in the roentgenogram as thickening and confluence of the hilar and parenchymal markings, which assume a characteristic stippling or mottling. Peribronchial infiltration was noted in 22.5 per cent of cases. This process is frequently seen at the parahilar and basal regions, usually on the right side. When the apex is involved reinfection tuberculosis, again, is strongly simulated. These parenchymal shadows may be associated with nodular lesions and hilar glandular swelling (Fig. 2) or they may be seen independently. Resolution may take place within a few weeks in many cases; in others, clearing may take place

over an appreciably long period of time.

Confluent Consolidations. Extension of the inflammatory process from the smaller and middle-sized bronchi to the terminal bronchioles and the alveolar walls, with associated productive and exudative response, produces demonstrable isolated or confluent areas of pulmonary consolida-

Pleural effusion may be associated. The pneumonic form of tuberculosis and bronchogenic carcinoma may simulate this appearance closely. Differentiation may be possible only after study of the associated clinical evidence and over a prolonged period of time.

Hilar Adenopathy. The tracheobronchial

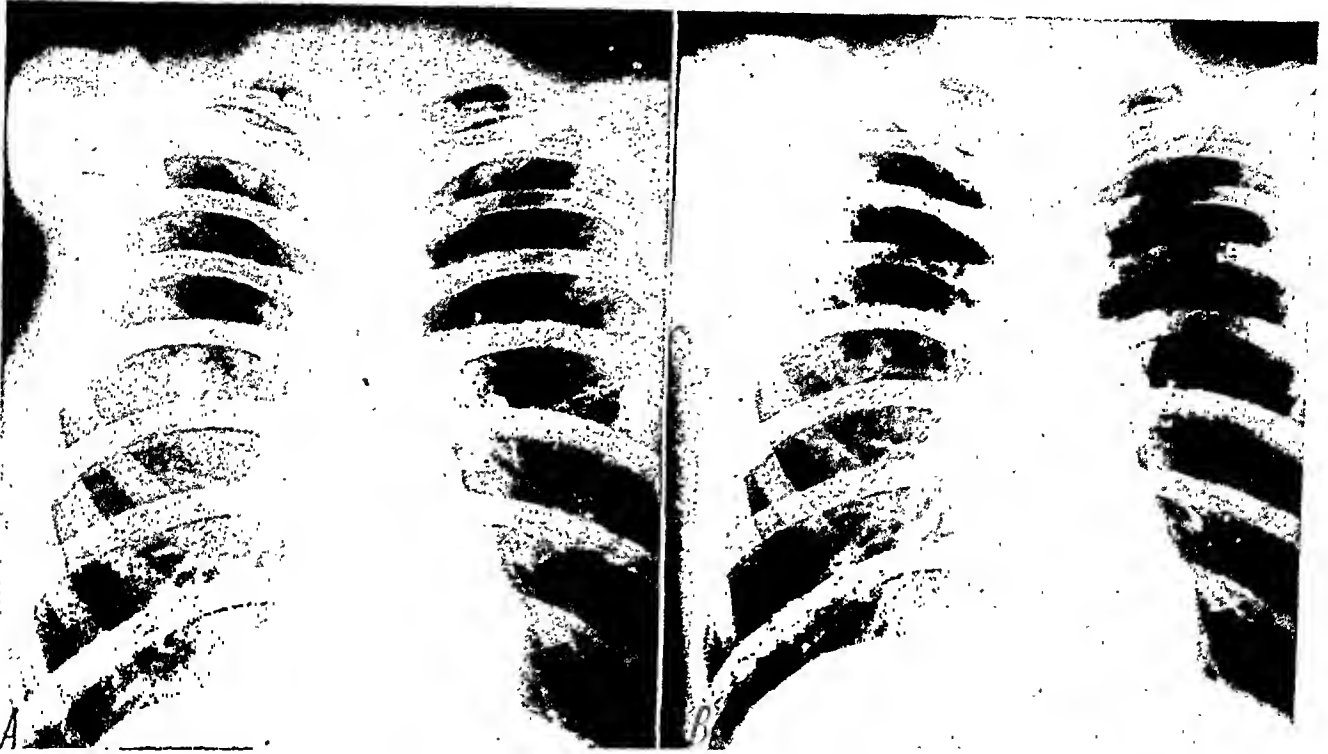


FIG. 1. *The Nodular Lesion. History and Clinical Features:* White, male, aged 30; had never previously been in California or Arizona. Admitted on October 26, 1943, with chest pain, cough, malaise and mild fever. *Coccidioides* (1:100) skin test was positive. Eosinophiles 13 per cent; sedimentation rate 26 mm. Complement fixation test strongly positive.

Roentgen Findings: (A) November 1, 1943. Roentgenogram shows a 2 cm., single, homogeneous nodule in the right mid-pulmonary field; edges are well defined. There is associated peribronchial thickening and haziness at the right cardiophrenic angle. Note the smaller sharply circumscribed nodule of slight density at the periphery of the left mid-pulmonary field. (B) December 27, 1943, shows beginning and partial clearing of the previously described nodule in the right mid-pulmonary field. The right cardiophrenic angle has cleared. The smaller nodule on the left is still present.

Disposition: Return to duty.

tion. These may be of bronchopneumonic or of lobar distribution. Progression and fusion of the nodular lesions combined with peripheral exudative reaction also may contribute to this appearance. Consolidation was observed in 20 per cent of the cases. The pneumonic consolidations in this disease are frequently characterized by their slow resolution. In some cases, clearing may take place after several weeks (Fig. 3). In others, there may be little change over a period of several months.

and bronchopulmonary glands frequently become involved as a hilar lymphadenitis. This was noted as a fairly pure form in 8 per cent of cases, and together with moderate peribronchial infiltration in 24.5 per cent. The adenopathy may be associated with a parenchymal nodular or exudative focus and with lymphangitic streaks radiating from the initial lesions to the hilum. These three components parallel closely the characteristic roentgen appearance of childhood tuberculosis. Depending upon the



FIG. 2. This case demonstrates a combination of bilateral nodulation and peribronchial infiltration. *History and Clinical Features:* White, male, aged forty-five; was located in Southern California Desert from July to December, 1943. Admitted December 19, 1943, with cough, chest pain, malaise and mild fever. Positive *Coccidioides* (1:100) skin test. Sputum examination was positive for endospores.

Roentgen Findings: (A) December 14, 1944, shows a nodular infiltration, 1.5 cm., irregular in outline, situated in the left mid-pulmonary field. Circumscribed, sharply delimited nodule, 1 cm. in diameter, situated at the right subapical region and another similar lesion at the right base. There is present an associated right parahilar and basal peribronchial infiltration. (B) January 27, 1944. Five weeks later. There is now complete clearing of the previously described lesions. Slight residual infiltrations at the left midpulmonic field and at the right base are still present.

Disposition: Returned to duty.

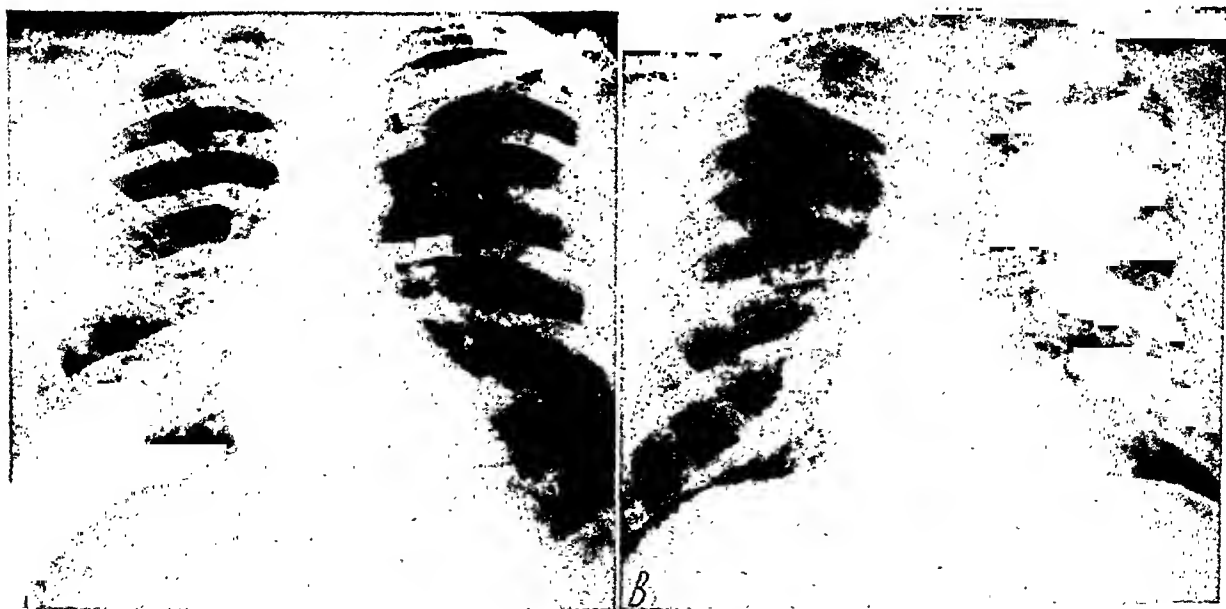


FIG. 3. *Partial Pneumonic Consolidation.* *History and Clinical Features:* White, male, aged nineteen; in Southern California Desert from August to November, 1943. Admitted in November with chest pain, cough, malaise, mild fever and erythema nodosum. Sedimentation rate 30 mm. Positive *Coccidioides* skin test (1:100). Complement fixation and precipitin tests were both strongly positive.

Roentgen Findings: (A) November 23, 1943, shows an area of pneumonic consolidation involving the base of the right upper lobe. (B) January 4, 1944, shows definite clearing, but a residual patch of consolidation is still present. Condition is that of a slowly resolving pneumonia.

Ultimate Disposition: Returned to duty.



FIG. 4. *Hilar Adenopathy. History and Clinical Features:* Negro, male, aged twenty-two, in California Desert from July to November, 1943. Admitted in November with cough, chest pain, malaise, mild fever and erythema nodosum. Sedimentation rate 61 mm. Positive (1:100) skin test. Complement fixation and precipitin tests were both positive.

Roentgen findings: (A) November 16, 1943, shows a moderate lymphadenitis involving the right hilar nodes. In the lower axillary portion of the right pulmonary field, there is seen a hazy, irregular infiltration of slight density and about 1.5 cm. in diameter. (B) On November 29, 1943, about three weeks later, there is seen beginning resolution of the right hilar enlargement. The slight density at the peripheral portion of the lower right pulmonary field is still present.

Ultimate Disposition: Returned to duty.

extent and severity of the disease, there may be gradual clearing (Fig. 4); or persistence of an enlarged, fibrotic and distorted hilum may be observed over several months (Fig. 5). This latter form may simulate the lymphoblastoma, the hilar form of bronchogenic carcinoma, sarcoidosis and hilar tuberculosis.

Pleural Effusion. The pleural inflamma-

tion may closely resemble the effusion of tuberculous etiology in both character and course. It may clear after a relatively short interval or may continue for a prolonged period. Pleural effusion was noted in 3 of our cases as an accompanying manifestation to a parenchymal initial focus. These effusions cleared rapidly and completely (Fig. 6).



FIG. 5. *Hilar Adenopathy; Associated Peribronchial Infiltration. History and Clinical Features:* Negro, male, aged forty-seven; in Southern California Desert from July to December, 1943. Admitted December 20, 1943, with cough, fever, chest pain. Sedimentation rate 47 mm. Eosinophiles 25 per cent. Positive *Coccidioides* (1:100) skin test. Complement fixation and precipitin tests were both strongly positive.

Roentgen Findings: January 28, 1944, shows severe right hilar lymphadenitis with associated peribronchial parahilar and basal infiltration. Slight peribronchial infiltration, left base. On February 26, 1944, about one month later, there was practically no change in the previously described appearances.

Cavity Formation. Cavities were noted in 3 of our cases. In 2 cases, the significant feature was the subsequent clearing after about a period of a month. The cavities were both thin walled and showed associated peripheral parenchymal reaction. In 1 case, which is described later in detail, a large cavity was surrounded by pneumonic consolidation and was considered to be primarily of tuberculous etiology. Em-

are to be considered as representing the mild or moderate roentgen form of this disease since, in most instances, resolution takes place within a period of about six to eight weeks and usually leaves but slight residuum. However, the possibility of generalized dissemination must always be considered, especially in these primary stage lesions which fail to clear and which assume a protracted course. Smith¹¹ describes such

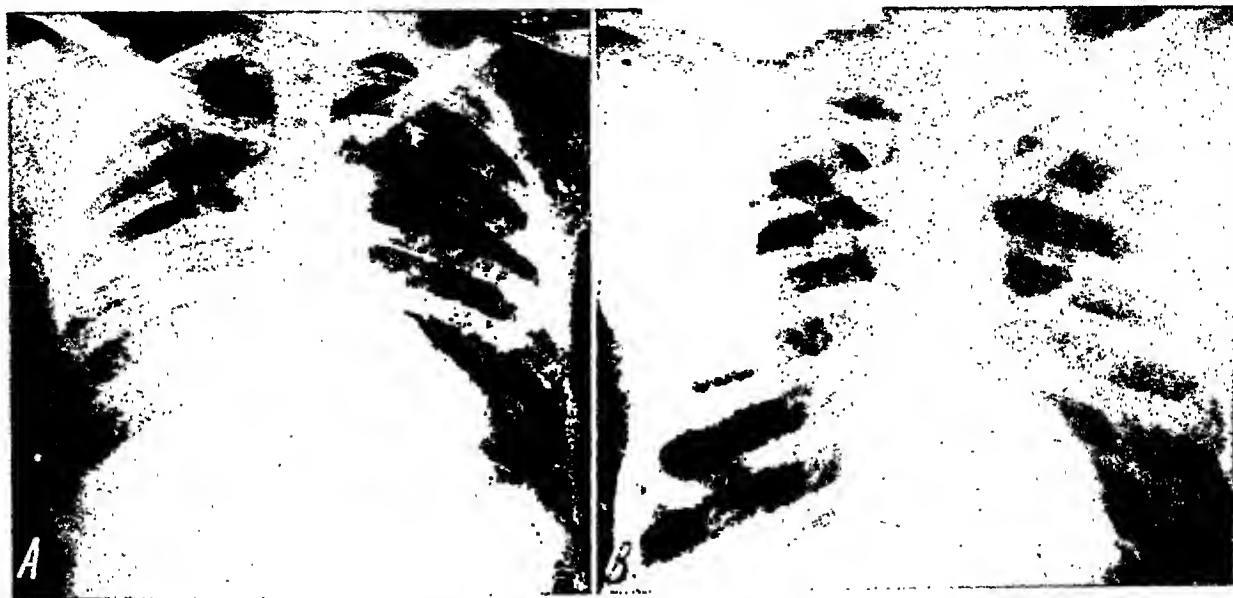


FIG. 6. This case represents a sequence of pulmonary infiltration, pleural effusion and cavity formation. History and Clinical Features: Negro, male, aged thirty-eight, in Southern California Desert from July until December, 1943, with cough, fever, chest pain. Sedimentation rate 55 mm. Positive *Coccidioides* (1:100) skin test. Complement fixation and precipitin tests were both strongly positive.

Roentgen findings: On December 31, 1943, a 1.5 cm. nodule was observed at the base of the right upper lobe. The right hilum was mildly accentuated. The transverse interlobar fissure was thickened. (A) January 15, 1944, shows a pleural effusion at the right base. A 2 cm. cavity is seen in the region of the right middle lobe. Follow up films showed progress of the effusion. (B) February 14, 1944, shows partial resolution of the previously described inflammatory processes. The right-sided pleural effusion shows noticeable clearing. Residual pleurisy is still present. The nodule at the base of the right upper lobe is still seen. The previously described cavity is no longer prominent. There is an associated peribronchial thickening at the right base.

physematous blebs and lung abscess may give similar appearances and necessitate differentiation from cavities in this disease. The coccidioidomycotic cavity is usually differentiated from its tuberculous counterpart by persistently negative sputa on repeated examinations.

Although the extent and distribution of the preceding roentgen appearances are rather widespread and are out of proportion to the mildness of the clinical course, they

a picture in 2 Filipino patients. In both cases, the disease progressed to coccidioidal dissemination. In each, the course was rapidly fulminating and fatal.

The roentgenological groups may frequently appear in combined form. Nodulation, exudation, pleural effusion and cavitation may all be present during the course of the primary disease and may produce a rather bizarre pulmonary picture. However, the individual factors contributing to

the combined pathological picture may easily be discerned on the roentgen examination. Although such nodular lesions, exudative and interstitial inflammations are characteristic of a multiplicity of pulmonary conditions, when a positive history is obtained with the previously described characteristic findings, an early roentgen diagnosis of primary pulmonary coccidioidomycosis is made plausible.

Bilateral Nodular (Local) Dissemination. Twelve patients in this series had in common this rather severe and extensive form of pulmonary involvement. It is notable that, of these 12 cases, 8 were Negroes. All 8 came from the same locality in the Southern California Desert and had been on duty approximately the same length of time, a period of about five months.

Characteristically in all of these cases, the roentgen examination showed a widespread distribution of nodular type lesions throughout the parenchyma of both lungs. This distribution appeared to be of a local disseminated type. The individual nodules were of similar size in some cases, and varied in size from about 5 mm. to 2.5 cm. in others. They were frequently sharply circumscribed in outline, closely resembling metastatic carcinoma, or were possessed of indefinite and feathery edges, then simulating bronchopneumonia. In this latter form, the margins of these lesions appeared to merge with the surrounding pulmonary parenchyma, which in turn showed areas of mottling and haziness due to bronchovascular infiltration. This form, because of the greater tendency to pneumonic consolidation, indicated a more severe prognosis. The nodules were usually seen disposed in relation to the tracheobronchial tree, being more numerous near the hilum and at the lower third of the pulmonary field, where they appeared to radiate off the main branches like clusters of grapes. Very frequently hilar lymphadenopathy, peribronchial infiltrations and parenchymal consolidations were associated, and these appearances also contributed to the impression of a more severe prognosis for these

cases. These typical nodular, bilateral infiltrations were seen in 20 per cent of the total number of cases.

This roentgen form may begin to show resolution within several weeks. However, when the infiltrations change slightly on serial studies, the progress from this condition to the granulomatous stage may follow either suddenly and violently, manifesting a short course or may take place slowly and perniciously over a long period of time.

In none of these 12 cases were any extrapulmonary manifestations noted, such as cutaneous, osseous or meningeal lesions. The absence of these manifestations, the relatively short duration of the disease, the presence of these nodules throughout the pulmonary fields apparently by a process of local extension rather than by hematogenous spread, all appeared to indicate that these patients were being observed in the primary stage of coccidioidomycosis rather than in the chronic or generally disseminated stage. It is notable that the distribution and persistence of these lesions are not only of roentgen diagnostic value in that these appearances may be consistent with this early and severe stage of the disease, but they are furthermore of considerable importance in that they modify the prognosis accordingly.

Fundamentally, however, as has been indicated in the consideration of the milder roentgen groups, the prognosis must be based on the established balance between the quality of the seed and the character of the soil. The roentgenological appearances, the erythema nodosum and the positive skin test all reflect the state of the patient's immunity and resistance. It is occasionally seen that a mild pulmonary lesion progresses to a fulminating generalized coccidioid dissemination within a few weeks in a sufficiently susceptible individual. On the other hand, this severe, bilateral, disseminated type may clear fairly rapidly in another individual who may have sufficient immunity to localize or wall off the infection.

The following case histories illustrate these conclusions and demonstrate the roentgenological character and course of this severe form of primary coccidioidomycosis. The first case in this group is an example of the bilateral, nodular, locally disseminated process, which has become

bases. On January 24, 1944, about five weeks later (Fig. 7B), partial resolution of these nodular areas had taken place; the lesions were now of smaller size and of linear shape. The hospital to which patient was later referred reported: "At present time, February, 1944, x-ray shows faint opacities well on way to resolution. Duty in ten days."



FIG. 7. *Bilateral (locally) disseminated type of primary coccidioidomycosis. Case 1. (A) December 20, 1943. Bilateral and multiple infiltrations throughout both pulmonary fields. The nodules are sharply circumscribed and appear to be well walled off. (B) January 24, 1944. Five weeks later. There is now partial resolution of the previously noted lesions. The nodules are of much smaller size and linear shape.*

well walled off and which shows adequate resolution of these multiple lesions in a period of about five weeks.

CASE 1. Negro, male, aged twenty-six; stationed in the Southern California Desert from June to December, 1942. Admitted on December 27 with cough, chest pain, malaise and mild fever. Eosinophiles 4 per cent, sedimentation rate 20 mm. per hour. Coccidioidin skin test (1:100) was positive. Complement fixation test on January 4, 1944, was positive; dilutions 1:2, 1:4, 1:8 were all 4+. Precipitin test was positive; dilutions 1:2, 1:10, 1:40 were all 4+.

Roentgen Findings. Examination on December 20, 1943 (Fig. 7A) showed both pulmonary fields to be occupied by multiple, nodular, sharply, circumscribed densities from apices to

The following 2 cases represent the severest, most potentially fulminating, form of the primary stage of this disease. The nodular lesions here are of a soft and diffuse nature, and remain relatively unchanged on repeated examinations. The prognosis is consequently grave. Both of these patients are candidates for the chronic granulomatous stage, if they have not already progressed to this secondary state. No skin or bone lesions were observed in this group. In Case III the negative skin test corresponds with a negative tuberculin test in an overwhelming tuberculous infection. Roentgenologically, a parallel situation was observed in that the pulmonary lesions showed practically no change on serial

roentgenograms over a period of about seven weeks. Furthermore, advanced right hilar adenopathy and confluent consolidation at the right base contributed to the severity of the disease.

CASE II. Negro, male, aged twenty-one; in Southern California Desert from July until December, 1943. Admitted December 14, 1943, with cough, chest pain, anorexia and high fever. Skin test for *Coccidioides* (1:100) was positive.

positive. The skin test for coccidioidomycosis was negative.

Roentgen Findings. Roentgen examination on January 27, 1944, showed both pulmonary fields to be involved by small nodular densities, with irregular hazy borders, varying from 5 mm. to 1.5 cm. in diameter. There was confluence of these nodules into a consolidated area in the right lower pulmonary field. An associated advanced right hilar adenopathy was present (Fig. 8B). The hospital to which the patient was later referred reported as follows:

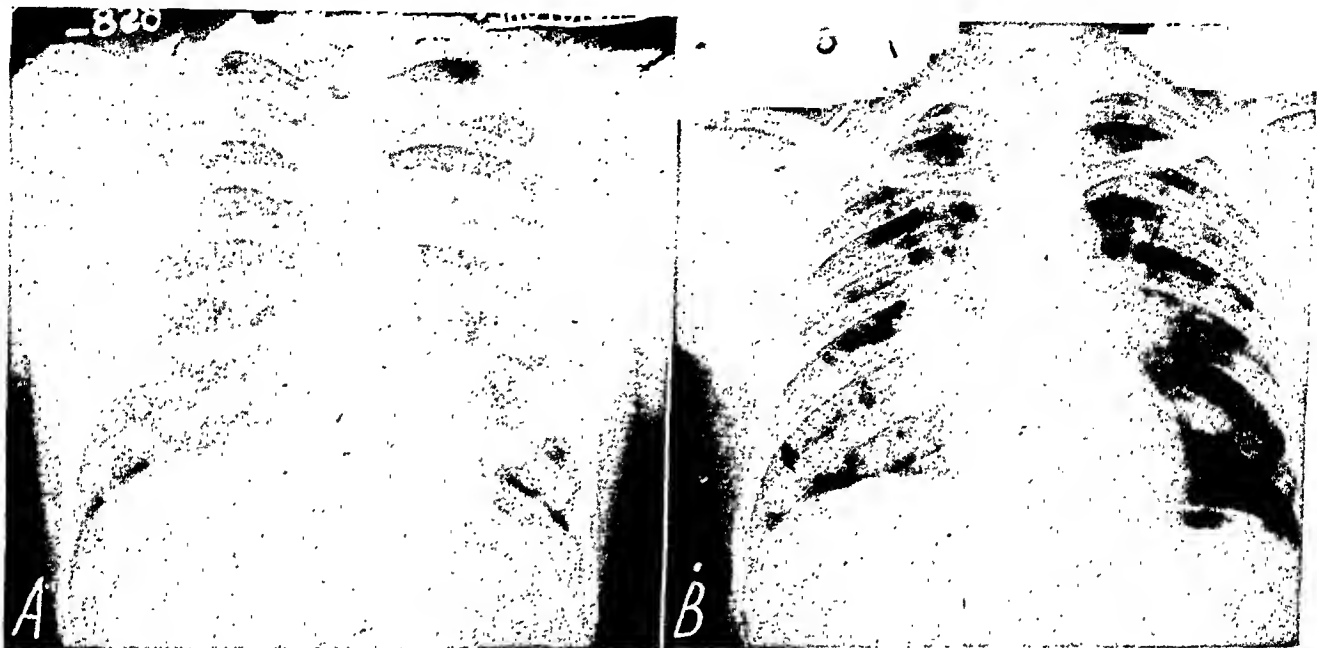


FIG. 8. Bilateral (locally) disseminated type of primary coccidioidomycosis; most fulminating form; prognosis poor.

(A) Case II. Both pulmonary fields are seen to be involved by multiple nodular lesions. The hazy and fuzzy edges indicate absence of a walling off process. There is marked surrounding inflammatory reaction.

(B) Case III. Both pulmonary fields are involved by small, irregular nodular densities. There is confluence of these nodules into an area of consolidation at the right base. Note the severe right hilar lymphadenopathy.

Sedimentation rate 32 mm. White blood count 18,000; eosinophiles 13 per cent. Complement fixation test on December 30, 1943, was 4+ in dilutions of 1:2 and 1:4. The precipitin test was positive.

Roentgen Findings. Examination on December 14, 1943, showed both pulmonary fields to be involved by multiple, nodular lesions with fuzzy and hazy irregular edges. The intervening parenchyma showed associated infiltrative changes (Fig. 8A).

CASE III. Negro, male, aged twenty-six; in Southern California from June to December, 1943. Admitted December, 1943, with cough, chest pain, moderate fever. Precipitin test was

"The x-ray film on March 11, 1944, showed many bilateral opacities which were large and fluffy in appearance."

The next case demonstrates how a member of this latter group with a roentgenological picture similar to that seen in Cases II and III may go on to rapidly fulminating and fatal miliary dissemination. The negative skin test probably indicated overwhelming infection.

CASE IV*. Negro, male, aged twenty-seven, was inducted into the United States Army in

* Courtesy Captain Donald Kent.

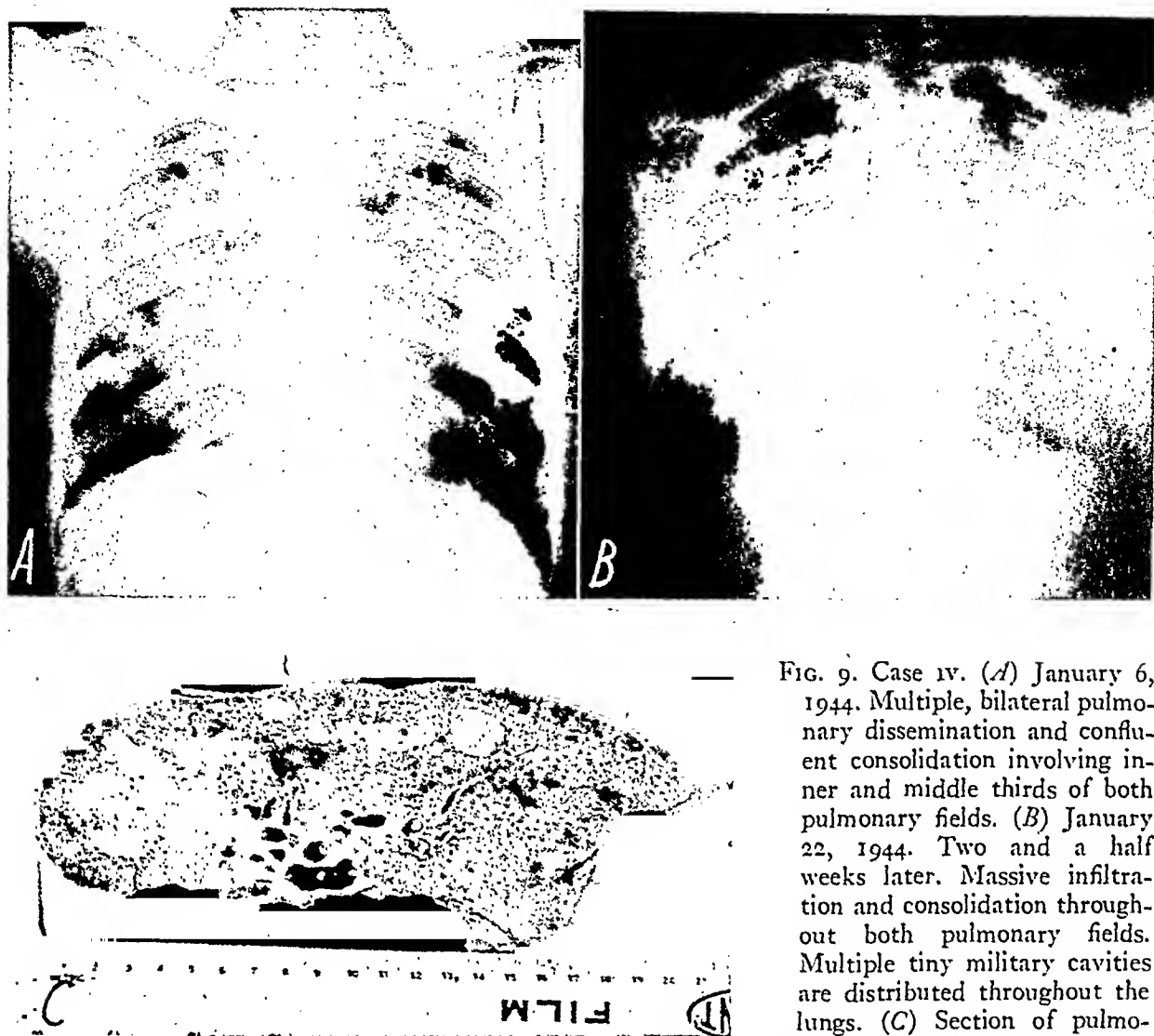


FIG. 9. Case IV. (A) January 6, 1944. Multiple, bilateral pulmonary dissemination and confluent consolidation involving inner and middle thirds of both pulmonary fields. (B) January 22, 1944. Two and a half weeks later. Massive infiltration and consolidation throughout both pulmonary fields. Multiple tiny military cavities are distributed throughout the lungs. (C) Section of pulmonary tissue. Note the presence

of the pale gray nodules and the multiple small cavities. Smears of material from the pulmonary cavities showed spores of *Coccidioides immitis*.

July, 1942. Patient was a native of North Carolina. Previous occupation was that of a saw-mill worker. Previous family and personal histories were essentially negative. The patient had never previously been in California, New Mexico or Arizona. He first arrived in the Southern California Desert in July, 1943.

In the latter part of December, 1943, patient developed a cold with a grippe-like onset; he had a mild cough, substernal pain and fever. He was admitted to an evacuation hospital where a chest roentgenogram taken on December 27, 1943, showed "dense and fuzzy mottled infiltrations throughout both lungs." The clinical examination showed moist râles and increased breath sounds at both pulmonary bases. Temperature on admission 100.8° F., pulse 100, respiration 22. The examination was otherwise

essentially negative.

Admitted to this hospital on January 5, 1944, because of continued fever. The coccidioidin skin test (1:100) was negative and remained so throughout the course. The complement fixation test was strongly positive in all dilutions. The precipitin test was strongly positive. Leukocyte count 11,000, with 87 per cent polymorphonuclears and 1 per cent eosinophiles; sedimentation 36 mm. Sputum was negative for tubercle bacilli and for coccidioidal spores.

Roentgen Examination on January 6, 1944 (Fig. 9A) shows an involvement of both pulmonary fields by multiple and nodular irregular densities. This process was as prominent in the remainder of the lung fields as in the apices and demonstrated no change as compared to pre-

vious roentgenogram of December 7, 1943. These nodular lesions were associated with surrounding areas of parenchymal infiltrations, especially in the regions of the inner and middle third of the pulmonary fields.

Clinical Course. The patient, on January 9, 1944, began to show a spiking temperature, which reached 103° F. in the afternoons, together with corresponding elevation of the pulse and respiratory rate. On January 20, clinical evidence of bronchopneumonia was observed. On January 21, sulfadiazine was started. On January 22, pneumococci were found in the sputum. In spite of vigorous supportive treatment, the patient's course was rapidly retrogressive and he died on January 23, 1944. Roentgen examination (Fig. 9B) January 22, about twelve hours prior to death revealed that practically the entire parenchyma was involved by a massively disseminated infiltrative process, with patchy areas of consolidation and with the presence of numerous tiny cavities of generalized distribution.

Pathological Findings (First Lieutenant W. B. Chamberlin, Jr., M.C.). Lungs: The pleurae were everywhere slightly thickened and roughened by fibrous adhesions. Scattered regularly throughout all lobes were a moderate number of roughly rounded cavities having an average diameter of approximately 1 cm. and not exceeding 15 mm. in diameter. These had a thin firm wall and were filled with pus and caseous material. Definite communication of some of them with smaller bronchi was noted. The lung tissue throughout was more firm than normal and only small portions of crepitant lung tissue were observed. Besides the cavities, moderate numbers of pale gray nodules 1 to 2 mm. in diameter were scattered throughout the lungs (Fig. 9C).

The pulmonary arteries and veins were normally patent and thin walled. The trachea and bronchi were partially filled with pus and caseous material. The mucosa of the trachea and main bronchi was smooth and glistening and showed no areas of ulceration. There was fusiform dilatation of some of the smaller bronchi in the vicinity of the cavities. Some of the smaller bronchi had granular mucosae.

The bronchopulmonary and mediastinal lymph nodes were all moderately enlarged, attaining a maximum diameter of 3 cm. They sectioned with ease, revealing mottled black, gray and white cut surfaces. Numerous pale

yellow nodules were seen in some of them. No primary tuberculous complex was identified.

Microscopic Findings. There was moderate hyperemia. The alveolar walls were thickened and the alveoli were filled with fibrin in which pus cells and mononuclear cells were seen. Organization of this exudate was evident in many places. A MacCallum stain showed no definite bacteria. Focally, there were small to large areas of necrosis surrounded by a border of granulation tissue in which Langhans' giant cells were seen. In the necrotic areas were many spores with double contoured capsules, morphologically identical with the spores of *Coccidioides immitis*. These spores were better seen in the bacterial stain. One section which included the wall of a large bronchus showed lymphocytic, plasma cell and pus cell infiltration of the mucosa and lamina propria.

A frozen section of mediastinal lymph node revealed spores of *Coccidioides immitis* as did smears of the material from the pulmonary cavities.

Associated Findings. Military coccidioidomycosis of spleen and mediastinal lymph nodes, liver and kidneys. Chronic obliterative peritonitis.

This last case illustrates an unusual combination of reinfection tuberculosis and coccidioidomycosis. The outstanding features in this case are the following: The presence of acid-fast bacilli and spores of *Coccidioides immitis* in the sputum; the negative coccidioides and tuberculin cutaneous tests and completely negative complement fixation and precipitin serological tests—all indicating a severe pulmonary invasion.

CASE V. Mexican, male, aged thirty, native of San Fernando, Mexico. Entered military service in January, 1943. Previous personal and family history was essentially negative. Hospitalized at a previous installation for seventeen days in November, 1943, because of fever. No diagnosis established. Admitted to another hospital on March 9, 1944; complaining of pain in the abdomen for four months, chest pain, weight loss of 20 pounds, and night sweats. Diagnosis of pulmonary tuberculosis was made here.

Admitted to this hospital on March 25, 1944, complaining of cough and chest pain. Physical

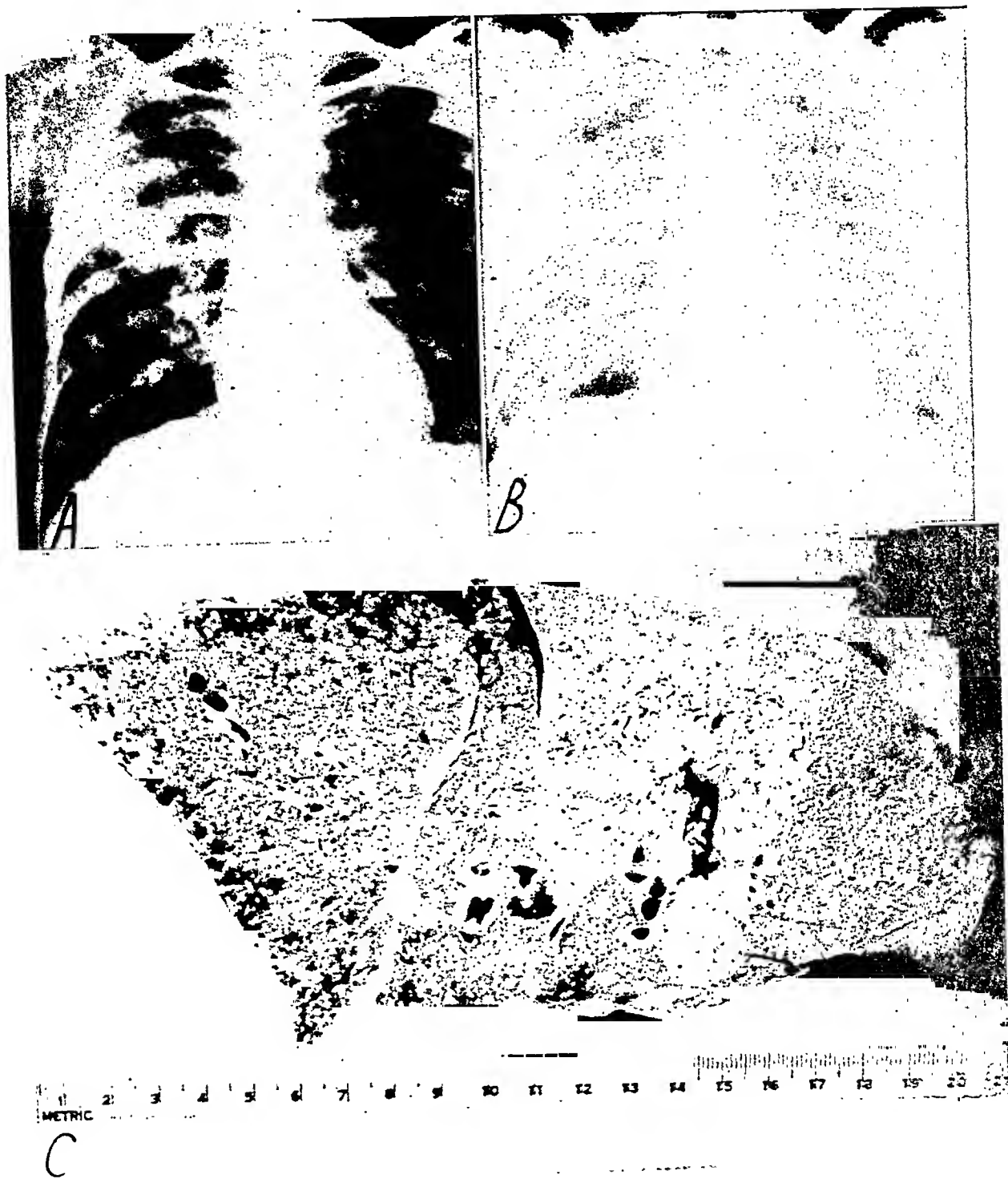


FIG. 10. Case v. (A) March 25, 1944. Roentgenogram shows an area of pneumonic consolidation involving the right upper lobe, in the central portion of which lies a cavity 2.5 cm. in diameter. Bronchopneumonic infiltration is present at the right base. (B) Five days later, there is an extensive spread throughout the pulmonary fields. (C) Section of pulmonary tissue. Note the consolidated lung tissue extending out from the right hilum. The central portion shows the previously described cavity. Small nodules are distributed throughout the remainder of the section.

examination: temperature, 103.8° F.; pulse 90; respiration, 24; blood pressure, 90/60. Physical signs of consolidation in right upper lobe; rest of physical examination negative.

Roentgen Findings. Examination on March 25, 1944 (Fig. 10A) showed an area of pneumonic consolidation in the right upper lobe with a cavity 2.5 cm. in diameter in the central

portion. There is associated bronchopneumonic type infiltration at the right base.

Follow-up roentgen examination on March 30 and April 1, 1944, showed rapid progress with extensive miliary type spread throughout both lungs (Fig. 10B).

Laboratory Findings. Erythrocytes, 4,300,000; hemoglobin, 85 per cent; leukocytes, 7,250, with 80 per cent polymorphonuclears, 18 per cent lymphocytes, and 2 per cent eosinophiles; Kahn reaction, negative; sedimentation rate, 34; hematocrit, 33; corrected rate, 13.

Skin Tests. Coccidioidin 1:100 negative; tuberculin 1:1000 negative.

Sputum showed acid fast bacilli and spores of *Coccidioides immitis*.

Complement fixation and precipitin reactions completely negative.

Hospital Course. Patient had a spiking temperature as high as 104.3° F., pulse up to 160 and respirations up to 80; chills and profuse sweating. He was given a 500 cc. blood transfusion on April 1, 1944. He was kept in an oxygen tent after March 29, 1944, but despite this he became progressively worse and died on April 3, 1944.

Pathological Findings (First Lieutenant W. Chamberlin, Jr. M.C.). Lungs (Fig. 10C):

The pleura over the right upper lobe was thickened with fibrinous adhesions, but elsewhere the pleurae were thin. Pushing the pleura up everywhere in both lungs were numerous pale gray to pale yellow nodules having an average diameter of 2 mm. These were in places confluent. Crepitation was everywhere reduced and the cut surfaces were studded everywhere with nodules similar to those seen under the pleura. Extending laterally from the right hilum was a band of consolidated lung tissue having pale yellow cut surfaces. This zone of involvement embraced the lower portions of the right upper lobe and right middle lobe and had an average width of 5 to 6 cm. In the center of this zone was a roughly oval cavity 3 cm. in maximum diameter filled with pus. It had roughened soft friable walls. Throughout this consolidated zone were many places where caseous material could be scraped out. In the left lower lobe adjacent to the bronchus was a firm pale yellow round mass 1 cm. in diameter. The trachea, bronchi and pulmonary vessels were of average caliber with thin glistening linings. The bronchopulmonary and mediastinal lymph nodes were slightly enlarged but

soft. They sectioned with ease revealing black cut surfaces mottled with pale gray.

Direct smears of the material from the cavity in the upper lobe of the right lung and from the nodules in the left lung revealed numerous spores of *Coccidioides immitis*.

Final Pathological Findings. (1) Acute ulcerative pulmonary coccidioidomycosis and tuberculosis, right upper lobe; (2) miliary coccidioidomycosis of the lungs; (3) acute fibrinous pleuritis, right. Associated findings were miliary coccidioidomycosis of spleen, lymph nodes, liver, and right kidney.

SUMMARY AND CONCLUSIONS

1. A series of 60 cases of primary coccidioidomycosis is presented, 6 proved by the isolation of the causative organism and 54 presumptive cases on the basis of clinical and laboratory findings.

2. The characteristic roentgenological manifestations, as observed in this series, are classified. A subgroup of 12 cases, representing an unusually widespread bilateral and severe locally disseminated form of the primary disease, is emphasized.

3. A relation between the inherent resistance of the host and the extent, severity and course of the pulmonary manifestations is indicated. Where the natural immunity is low, as is seen in the dark-skinned races, the disease may assume its most fulminating form and rapidly progress to generalized coccidioidal dissemination.

4. The pathological findings in 2 cases which came to autopsy are presented. Correlation of these with the roentgen appearances is demonstrated. The first case is an example of a generalized, fulminating, miliary coccidioidomycotic process which was superimposed upon the bilateral, multiple and severe form of primary pulmonary coccidioidomycosis. The second case is an unusual example of a combination of active tuberculosis and coccidioidomycosis.

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REFERENCES

1. CARTER, R. A. Coccidioidal granuloma: roentgen diagnosis. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1931, 25, 715-738.
2. CARTER, R. A. Roentgen diagnosis of fungous infections of the lungs with special reference to coccidioidomycosis. *Radiology*, 1942, 38, 649-659.
3. COLBURN, J. R. Roentgenological types of pulmonary lesions in primary coccidioidomycosis. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 51, 1-8.
4. DICKSON, E. C. "Valley fever" of the San Joaquin Valley and fungus coccidioides. *California & West. Med.*, 1937, 47, 151-155.
5. FARNES, O. J. Coccidioidomycosis. *J. Am. M. Ass.*, 1941, 116, 1749-1752.
6. GOLDEN, R. Editor. *Diagnostic Roentgenology*. Thomas Nelson & Sons, New York.
7. OPHÜLS, W., and MOFFIT, H. C. New pathogenic mold (formerly described as a protozoon; *Coccidioides immitis pyogenes*). *Philadelphia M. J.*, 1900, 5, 1471-1472.
8. POWERS, R. A., and STARKS, DOROTHY, J. Acute (primary) coccidioidomycosis; roentgen findings in a group "epidemic." *Radiology*, 1941, 37, 448-453.
9. RIXFORD, E. Case of protozoic dermatitis. *Occidental M. Times*, 1894, 8, 704-707.
10. SCHULZE, V. E. Acute coccidioidomycosis in west Texas. *Texas State J. Med.*, 1942, 38, 372-376.
11. SMITH, C. E. Parallelism of coccidioidal and tuberculous infections. *Radiology*, 1942, 38, 643-648.
12. WERNICKE, R. Ueber einen Protozoenbefund bei Mycosis fungoides (?). *Centralbl. f. Bakteriol.*, 1892, 12, 859-861.
13. WINN, W. A. Pulmonary cavitation associated with coccidioidal infection. *Arch. Int. Med.*, 1941, 68, 1179-1214.

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INTERLOBAR EMPYEMA*

By LIEUTENANT COLONEL JOSEPH LEVITIN

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WITH recent progress in the field of chemotherapy and the advent of penicillin in the treatment of infections, pulmonary complications are of less frequency and are not anticipated. As a result, the earlier work in the diagnosis of interlobar empyema (Clairmont,¹ Dieulafoy²) has almost been forgotten, and the diagnosis is established late or not at all. Roentgenology has so greatly facilitated the diagnosis of diseases of the chest that there has been a tendency to neglect, to a certain extent, the history and physical examination. This has been a disadvantage in the diagnosis of interlobar empyema, for the roentgen findings, though they may be highly suggestive, often do not give sufficient data to make such a diagnosis. The roentgen findings must be correlated with the history, the chain of events and the symptoms of the patient.

Interlobar empyema is a collection of pus in the interlobar fissure. These fissures lie between the lobes of the lung and connect freely with the pleural cavity. If adhesions unite the edge of the fissures we have a closed sac with retention of fluid, resulting in an encapsulated pleurisy. The sac itself may be divided by adhesions into multiple sacs and we may have only partial collections of fluid. This, of course, would make the roentgenological diagnosis more difficult.

The anatomy and the situation of the fissures has been well studied (Levitin⁴) (Fig. 1-11). The main fissure starts at about the level of the fourth rib posteriorly and courses obliquely forward. At the level of the hilum on the right side another fissure extends horizontally forward, dividing the right superior lobe into an upper and a middle portion. The appearance of the fissures, as seen on the roentgenogram, has

been studied and described (Levitin and Brunn⁵). The situation of the fluid alters the true anatomic direction of the fissures in their true anatomic location. Previous chest pathology, such as adhesions or atelectasis, also alters the position of the fissure on the roentgenogram.

For a roentgen diagnosis of an interlobar effusion, anteroposterior and lateral views should be taken. Oblique views are in favor by the cardiologist to study enlargement of the auricles. It is also desired by the phthisiologist to demonstrate the presence of tracheobronchial glands. Oblique views are not satisfactory in the diagnosis of interlobar effusions. Except for the fissure between the right upper and middle lobes, oblique views cannot differentiate fluid in the interlobar fissures from partially consolidated lung (Fig. 1-11).

An interlobar aseptic effusion cannot be differentiated on the roentgenogram from an interlobar empyema. Pus does not cast a different shadow on the film from an aseptic effusion. Once the location of the shadow is established on the roentgenogram in the interlobar fissure, the history and physical findings must be carefully correlated to establish a diagnosis of empyema rather than an aseptic effusion.

DIAGNOSIS OF INTERLOBAR EMPYEMA

The symptoms of the onset of an interlobar empyema are the same as those of pneumonia and pleural effusion with pain on the affected side, fever and cough. There is a difference in the amount of dyspnea, which is not so marked with fluid lying in the free pleural cavity as when it is encapsulated between the lobes of the lung or between the lobes and diaphragm. After a few days of cough and fever the characteristic crepitant râles, tubular breathing and

* This article is based on material collected from the Department of Roentgenology, Mount Zion Hospital, San Francisco, before entering military service.

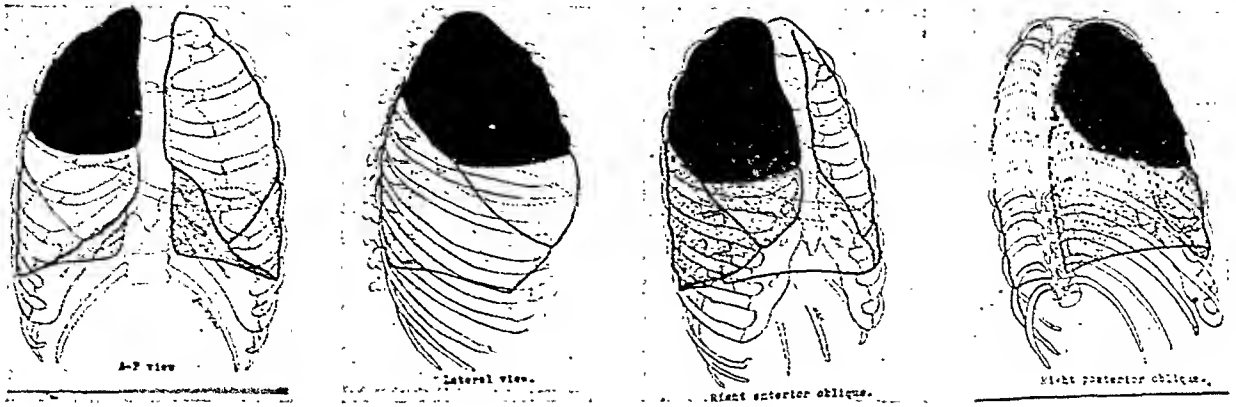


FIG. 1. The right upper lobe.*

* The anteroposterior and lateral diagrammatic views of the lobes of the lung and interlobar fissures in the figures are reproduced by permission from *Radiology*, 1935, 25, 651-680.

rusty sputum of pneumonia are not found. There is a relative absence of physical signs as a healthy lung may surround the encapsulated pus. We may find a zone of dullness and tubular breathing from engorgement of the parts contiguous to the fissure, if it should lie close to the pleural surface. It is at this stage that a roentgen examination of the chest is so important, as it will demonstrate an area of density localized to the interlobar space. Hemoptysis has been noted, which may lead one to suspect a tuberculosis. This hemoptysis is due to ulceration of the walls of the interlobar space.

An important finding is the character of the sputum. Sputum is brought up late in the disease and is foul, containing considerable pus. It results from rupture of the encapsulated empyema into a bronchus. It is similar to the sputum in a lung abscess. The sputum can be predicted from one to

several days in advance, before its evacuation, by the occurrence of a fetid breath. This is explained by escape of the fetid odors through small fissures developing between the interlobar space and the smaller bronchioles not large enough to allow the evacuation of the pus. The mode of expectoration of the pus is very characteristic of the disease. The patient is seized with a sudden fit of coughing and acute dyspnea followed by evacuation of purulent sputum which may be in large amounts. It is this purulent sputum which has given rise to the erroneous diagnosis of lung abscess. The history of fever, dyspnea, fetid breath and foul sputum, coupled with a roentgen diagnosis of interlobar effusion, establishes a diagnosis of an interlobar empyema.

TREATMENT

It is unusual for the encapsulated empyema to completely evacuate itself. Spon-

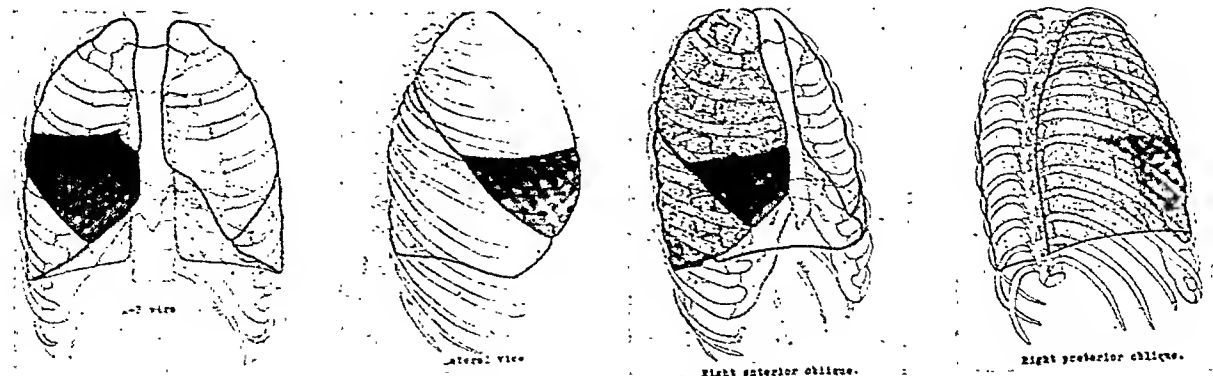


FIG. 2. The right middle lobe.

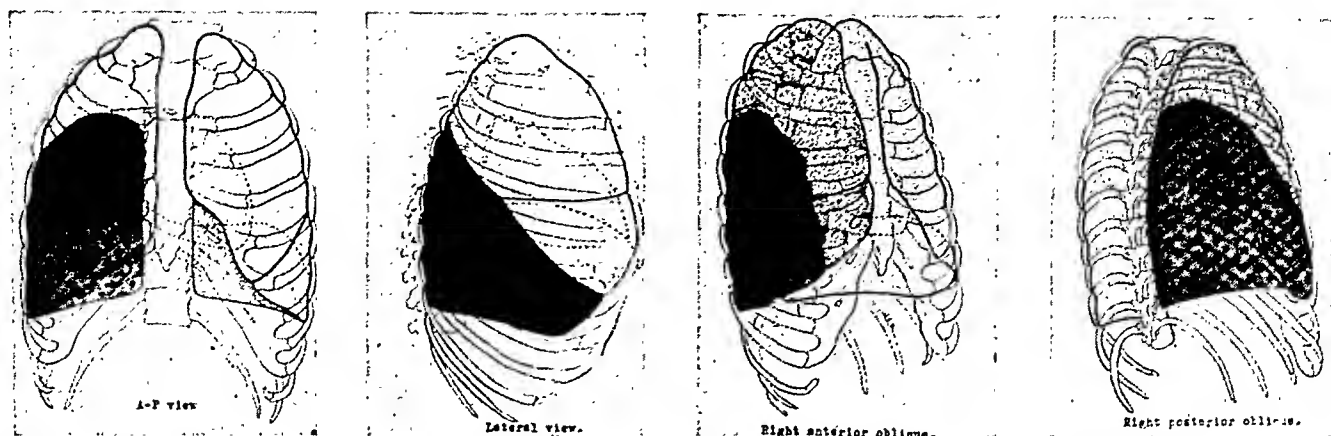


FIG. 3. The right lower lobe.

taneous evacuation should not be awaited as it implies the presence of bronchial fistulas and lung destruction. When the diagnosis is established surgery is indicated.

CAUSES

The causes of interlobar empyema are as follows:

1. Pneumonia.
2. Metastatic blood or lymphatic borne infection.
3. Direct trauma.
4. Lung abscess.
5. Primary infection.

1. *Pneumonia* is the etiologic factor in about 75 per cent of cases. Oftentimes the interlobar empyema is not recognized clinically and may be considered an unresolved pneumonia.

2. *Metastatic Blood or Lymphatic Borne Infection.* Septic thrombi may be carried by the blood stream from distant foci such as a purulent appendicitis, thrombophlebitis, and so forth, and lodge in that part of the

lung neighboring a fissure and cause an interlobar empyema. Clairmont described 3 such cases, 1 following a furuncle of the neck, a second from a thrombosis of the left saphenous vein followed by infarcts in both lungs and a third case followed a resection of the stomach for carcinoma. Roentgenograms of the chest in all 3 cases showed an interlobar effusion, and at operation an interlobar empyema was found.

The lymphatics can also carry infection directly into the lung and interlobar fissure. The lymphatic communications between the hilar glands to the lymphatics of the fissures are well known. Not as commonly appreciated is the communication between lymphatics of the abdomen and chest. Empyema following acute appendicitis was so frequent in past years that it had its own term and was known as appendicular pleurisy (Dieulafoy). The literature in those days had frequent mention of interlobar empyema following abdominal surgery. Such transportation of infection is

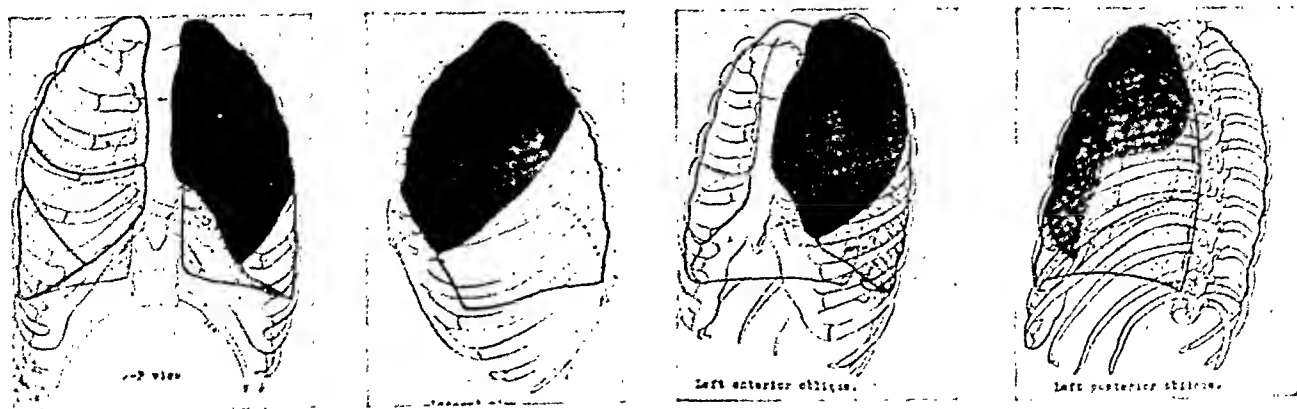


FIG. 4. The left upper lobe.

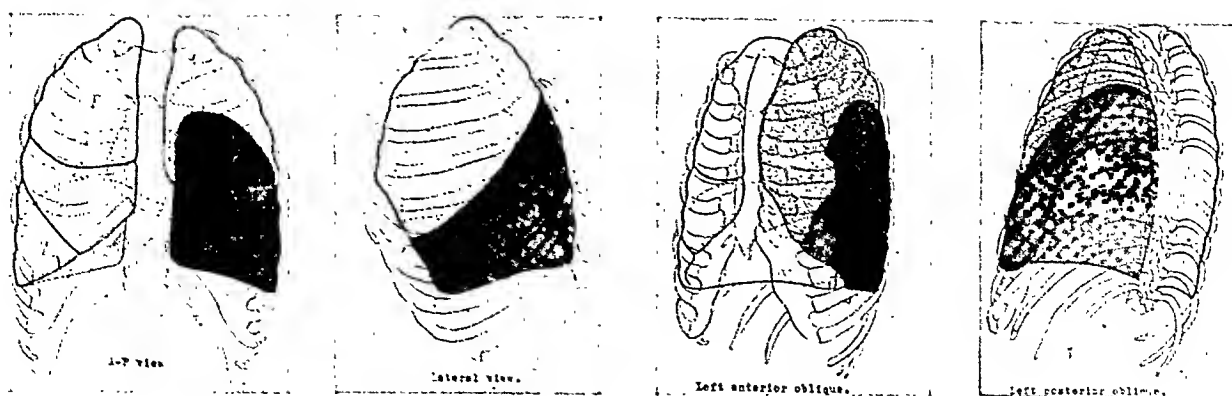


FIG. 5. The left lower lobe.

not so frequent today because the diagnosis of acute appendicitis is made earlier and the appendix is removed before complications develop.

Clairmont described 3 cases of lymphatic borne interlobar empyema following abdominal surgery. One followed eight days after an operation for a purulent appendiceal abscess with peritonitis. The second case had an operation for perforated duodenal ulcer, which was followed by a subphrenic abscess, gangrene of the right lower lobe and interlobar empyema. The third case was a resection for a duodenal ulcer. All 3 cases had the diagnosis of interlobar empyema confirmed at operation. He concluded from these 3 cases that an infection starting in the subhepatic space may jump over the subphrenic space and be carried by the lymphatics into the interlobar fissure. Another case occurring at Mount Zion Hospital also demonstrated the transportation of infection through the intact diaphragm. This patient had a ruptured

appendix and peritonitis. On the thirtieth postoperative day he showed clinical and roentgen evidence of subdiaphragmatic abscess. Four days later he had effusion in the right pleural cavity and between the right upper and middle lobes. Foul pus was removed by thoracentesis. The same type of organism, *B. coli*, cultured from the peritonitis at time of operation, was found in the pus from the chest. In spite of operative and supportive treatment he died. Post-mortem examination of the diaphragm showed it to be intact, no evidence of an ulceration, thick old adhesions on the peritoneal side in the region of the subphrenic abscess and adhesions, not so old, on the pleural side. Stained section of the muscle of the diaphragm showed *B. coli* within the fibers.

MacCallum⁷ demonstrated the manner by which materials are transported through the diaphragm from the peritoneum into the pleural cavity by study of the anatomy of the tissues which separate the lumen of

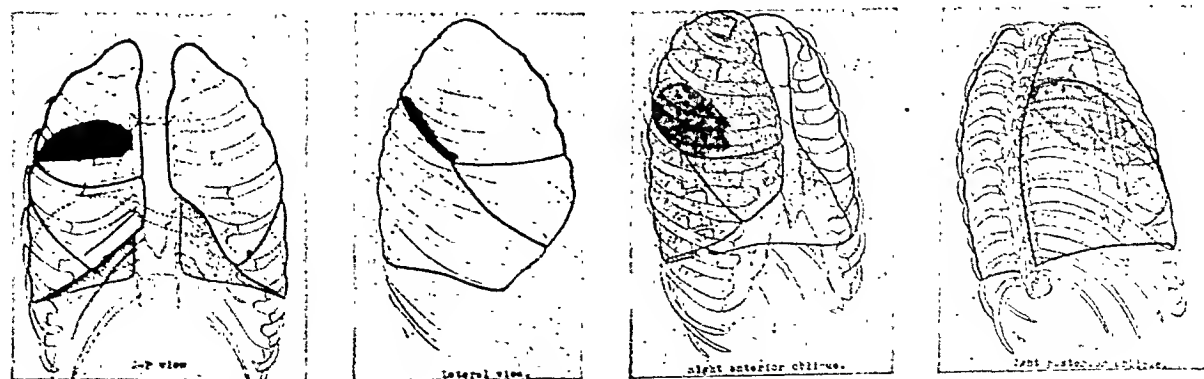


FIG. 6. The fissure between the right upper and right lower lobe.

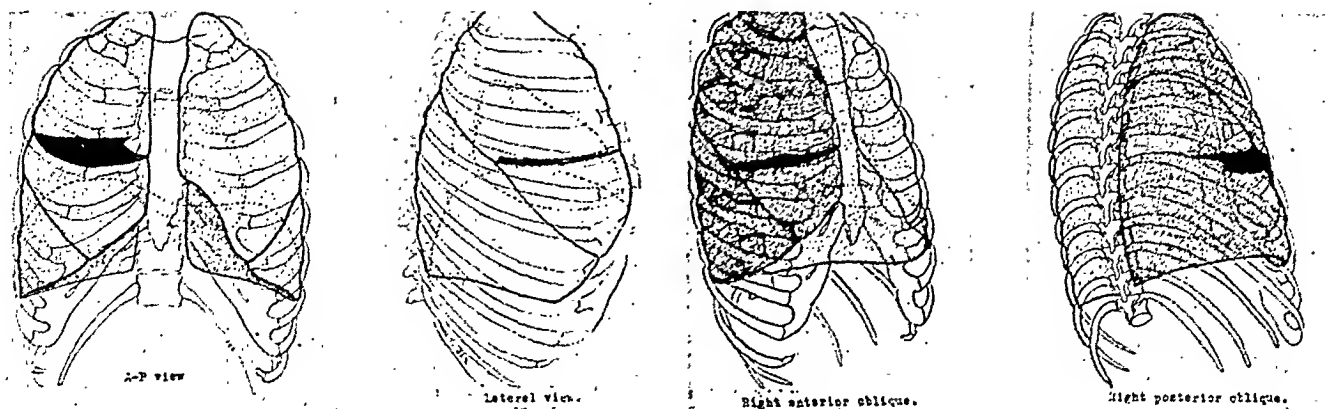


FIG. 7. The fissure between the right upper and right middle lobe.

the lymphatic channels from the cavity of the peritoneum. He found the lymphatics on the pleural surfaces of the diaphragm to anastomose abundantly, forming a network over the whole surface. On the peritoneal surface of the diaphragm the lymphatics lie in spaces between connective tissue fibers and are separated from the peritoneal cavity by a thin layer of tissue. These thin areas are the site for entrance of materials from the peritoneum. They are in the shape of sacs or lacunae which are absorbing terminals of the diaphragmatic lymphatics and are separated from the peritoneal cavity by loosely woven connective tissue and the peritoneal epithelium. Absorption of the granular material was brought about by phagocytosis. The peritoneum is not part of the lymphatic system and nowhere do the cells of each merge. It is possible to trace injected material from the sacs into the anastomosing trunks of the pleural network, then into efferent trunks and on into the mediastinal lymph glands.

The lymphatic borne pleural complication from infections in the abdomen occurs from about the seventh to the twentieth day after the onset of the infection. It is preceded by pain in the right hypochondrium radiating to the shoulder, as a result of infection either in the liver or subphrenic space. Pleurisy follows and there may be considerable effusion. The fever may be variable, but there is dyspnea, toxicity, loss of strength and a weak pulse. A pneumothorax may be present from the putrefactive organisms and does not necessarily indicate connection with a major bronchus. The course may be very rapid or there may be an encapsulation either in the pleural cavity or the interlobar fissure followed by expectoration of pus and symptoms as enumerated above.

3. *Interlobar Empyema from Chest Wound.* After a chest wound an interlobar effusion may develop which is in the nature of a serous or purulent exudate and is the result of direct trauma to the pleura or lung.

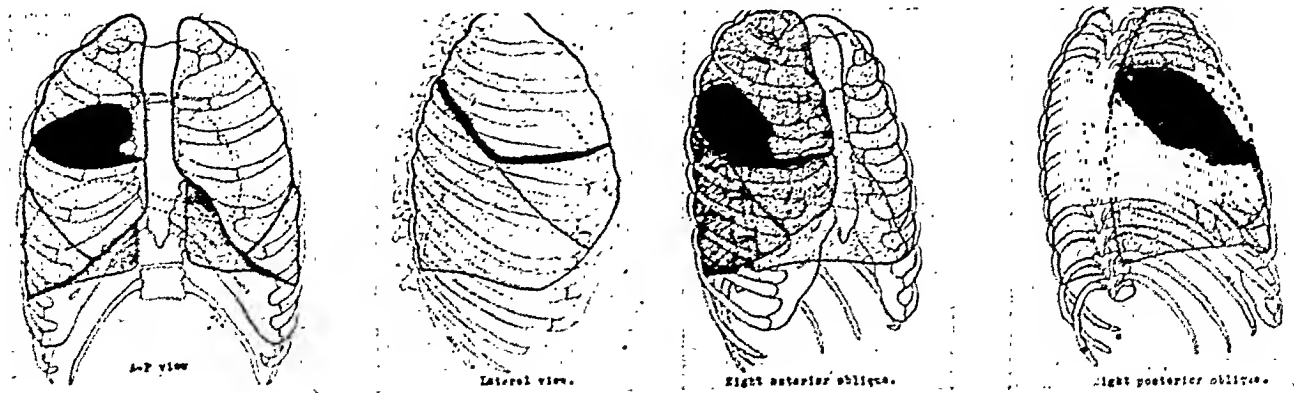


FIG. 8. The fissure surrounding the right upper lobe (upper and middle lobe anteriorly and upper and lower lobe posteriorly).

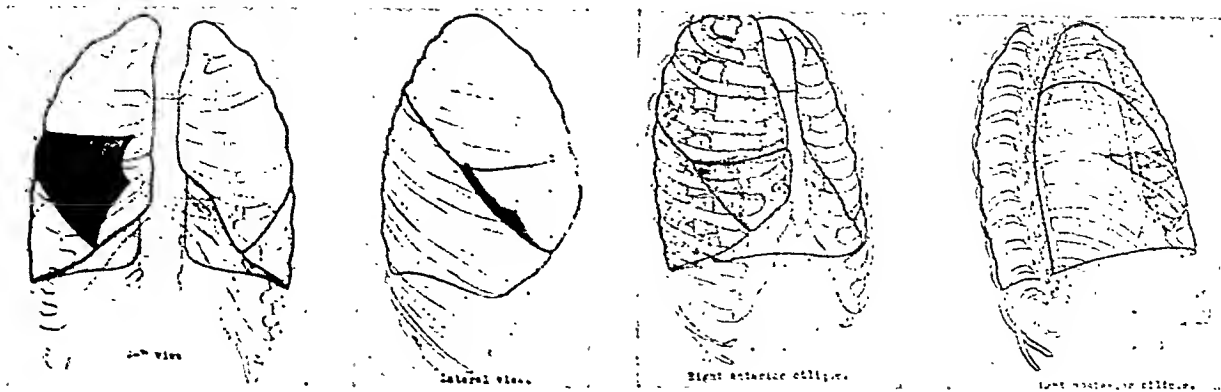


FIG. 9. The fissure between the right middle and lower lobes.

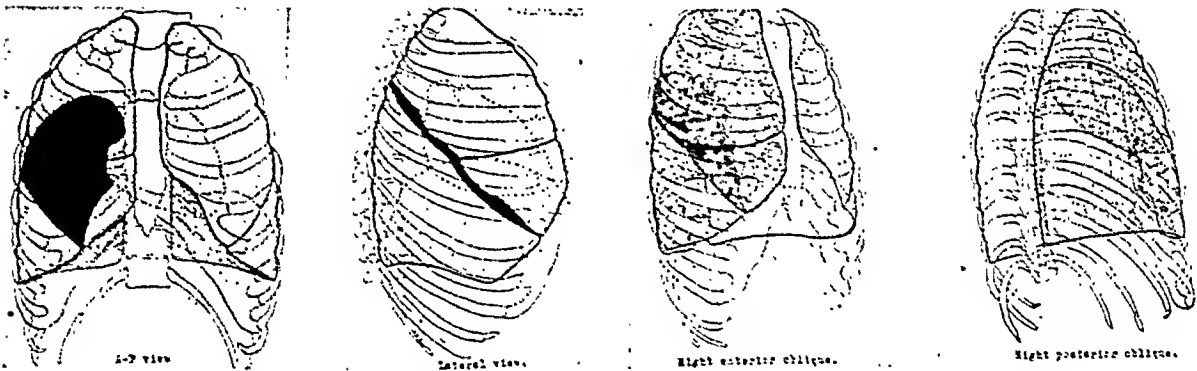


FIG. 10. The fissure bordering the upper surface of the right lower lobe.

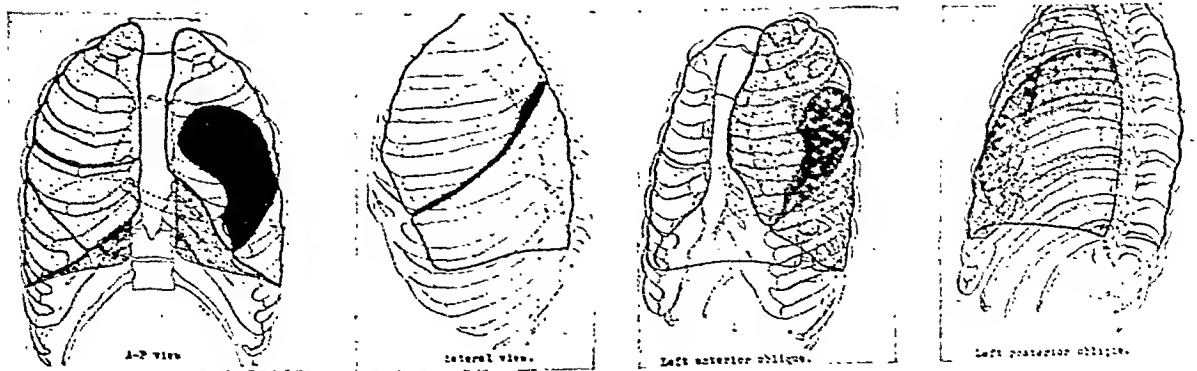


FIG. 11. The fissure between the left upper and left lower lobes.

Clairmont described a case of gun shot wound followed by subphrenic abscess and interlobar empyema. Straus⁸ reported a case three weeks after an injury from a knife wound in the chest. An empyema was found and drained, with recovery.

4. *Interlobar Effusion Associated with Lung Abscess.* Lung abscess is far more frequent than interlobar empyema and an empyema is often incorrectly diagnosed when an abscess is present. The abscess cavity may rupture into the interlobar space and give rise to an interlobar empyema, or the reverse may be true—an interlobar empyema may rupture into the lung and give an adjacent lung abscess. Cases of interlobar empyema caused by a lung abscess have been reported by Weinberg,¹⁰ Lilienthal,⁶ Donzelot and Iselin,³ Tixier and de Sèze.⁹

5. *Primary Infection.* Not all cases of interlobar empyema give a preceding history of pneumonia, distant infection or trauma. Dieulafoy suggested the possibility that an interlobar empyema may be a primary infection, just as we have a primary peritonitis, pleurisy or meningitis.

CONCLUSION

1. Interlobar empyema has a definite clinical syndrome. It is a complication which may follow

- a. Pneumonia.
- b. Metastatic infections carried by blood stream or lymphatics.
- c. Lung abscess.
- d. Trauma.
- e. Occur as a primary infection.

2. The characteristic history is pain on the affected side, fever, cough and dyspnea. The sputum is the most important finding which is foul, and simulates a lung abscess. The expectoration of sputum is preceded by fetid breath. The sputum occurs later in

the disease and indicates rupture of the empyema into a bronchus.

3. Roentgen examination is the most important single aid in diagnosis. Proper examination in the anteroposterior and lateral views will localize the abnormal density into the interlobar fissure. Roentgen examination cannot differentiate the aseptic from septic fluid.

4. Treatment of an interlobar empyema is surgical.

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REFERENCES

1. CLAIRMONT, P. Die interlobare Pleuritis. *Arch. f. klin. Chir.*, 1919, *III*, 335.
2. DIEULAFOY, G. Textbook of Medicine. Vol. I. D. Appleton & Co., New York, 1912, pp. 335, 358.
3. DONZELOT, E., and ISELIN, M. Pleurésies interlobaires et abcès du poumon. *Presse méd.*, 1931, *39*, 1625-1627.
4. LEVITIN, J. Roentgenological position of potential interlobar spaces. *Radiology*, 1934, *23*, 629-634.
5. Levitin, J., and BRUNN, H. Study of roentgenologic appearance of lobes of the lung and interlobar fissures. *Radiology*, 1935, *25*, 651-680.
6. LILIENTHAL, H. Abscess of lung, interlobar empyema. Death. Necropsy. *Surg. Clin. North America*, 1931, *II*, 483-486.
7. MACCALLUM, W. G. On the mechanism of absorption of granular materials from the peritoneum. *Bull. Johns Hopkins Hosp.*, 1903, *14*, 105-116.
8. STRAUS, F. H. Interlobar empyema from knife wound; drainage. *Surg. Clin. North America*, 1929, *9*, 435-438.
9. TIXIER, L., and DE SÈZE, S. Abcès streptococcique du poumon droit avec pleurésie interlobaire sero-fibrineuse et aseptique. *Bull. et mém. Soc. méd. d. hôp. de Paris*, 1929, *53*, 19-24.
10. WEINBERG, J. A. Chronic interlobar empyema complicating lung abscess. *Nebraska M. J.*, 1929, *14*, 445-447.



MULTIPLE FRACTURES IN THE LONG BONES OF INFANTS SUFFERING FROM CHRONIC SUBDURAL HEMATOMA*

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FRACTURES of the cranium are not infrequently associated with infantile subdural hematoma but fractures in the long bones have rarely been reported as complications of this intracranial lesion. An old fracture of the radius is mentioned by Sherwood¹ in his fifth case. Ingraham and Heyl² demonstrated greenstick fractures roentgenographically in the radiuses and ulnas of both forearms of one infant (Case 4) in whom there were neither clinical signs of fracture nor history of injury. Dr. Ingraham has written me that in his extensive experience with more than 100 cases of infantile subdural hematoma, fractures were also found in the humerus of one patient; in the femur of another; and in six ribs of a third.³

For many years we have been puzzled by the roentgen disclosure of fresh, healing and healed multiple fractures in the long bones of infants whose principal disease was chronic subdural hematoma. The subject of this paper is the description of 6 such patients who exhibited 23 fractures and 4 contusions of the long bones. In not a single case was there a history of injury to which the skeletal lesions could reasonably be attributed and in no case was there clinical or roentgen evidence of generalized or localized skeletal disease which would predispose to pathological fractures.

CASE REPORTS

CASE 1. H. D., male, was born March 13, 1925, after a normal gestation and labor; the birth weight was 8½ pounds. He gained and developed normally on a whole milk formula.

A purulent discharge from the right ear began at five months and continued for two months. At seven months there was a single

convulsion which lasted for one-half hour, after which the infant was weak and listless for three days and strabismus with stare developed. During this period fever was present and vomiting was frequent. The mother, who had been with the infant continuously, had not observed injury to the head or extremities. Physical examination disclosed a tense bulging anterior fontanel, internal strabismus and exaggerated deep reflexes. There were no signs of meningeal irritation. The bones of the left forearms were thickened to palpation and this finding raised the question of an old fracture with callus. Roentgenograms of the extremities were not made at this time. Forty-five cubic centimeters of cerebrospinal fluid were withdrawn from the lumbar subarachnoid space; the pressure was increased but the fluid was normal chemically and microscopically. Following lumbar puncture the signs and symptoms disappeared; the patient was sent home after three days with the diagnosis of hydrocephalus of unknown origin.

Two weeks later the patient began to vomit and the bulge over the fontanel reappeared; 35 cc. of lumbar cerebrospinal fluid were found to be crystal clear and normal microscopically and chemically. During the next five weeks 30 to 40 cc. of normal cerebrospinal fluid were withdrawn during each of 12 lumbar punctures. At nine months of age subdural punctures yielded 25 cc. of bloody fluid from the right angle and 15 cc. from the left angle of the anterior fontanel. Roentgenograms of the skull after the injection of air into the subdural space demonstrated a large cavity which extended over both cerebral hemispheres but which did not appear to communicate with the subarachnoid or ventricular spaces. The patient was discharged December 24 to spend the Christmas holiday at home.

On December 28 the infant was re-admitted for further study and treatment. The four day sojourn at home had been uneventful and re-

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examination showed that the fontanel was depressed and widely open. A weakness of the right side of the face was noticeable when the patient was crying. The therapeutic lumbar punctures and subdural punctures were discontinued. On January 6, after nine days of continuous hospital residence, swelling of the right wrist was detected—slight dorsal swelling with ecchymosis and tenderness. No unusual trauma had been observed by any of the hospital attendants. Roentgenograms showed a

fed from a bottle until the eleventh month. Cod liver oil was given after the fifth month and $1\frac{1}{2}$ ounces of orange juice were taken daily after the sixth month. Gain in weight was slow; at one year he weighed only 16 pounds.

During the seventh month the gums became swollen and hemorrhagic. In the tenth month blood was found in vomitus and feces. At the same time bluish and black spots appeared on the skin of the face and arms. The patient is said to have taken $1\frac{1}{2}$ ounces of orange juice daily

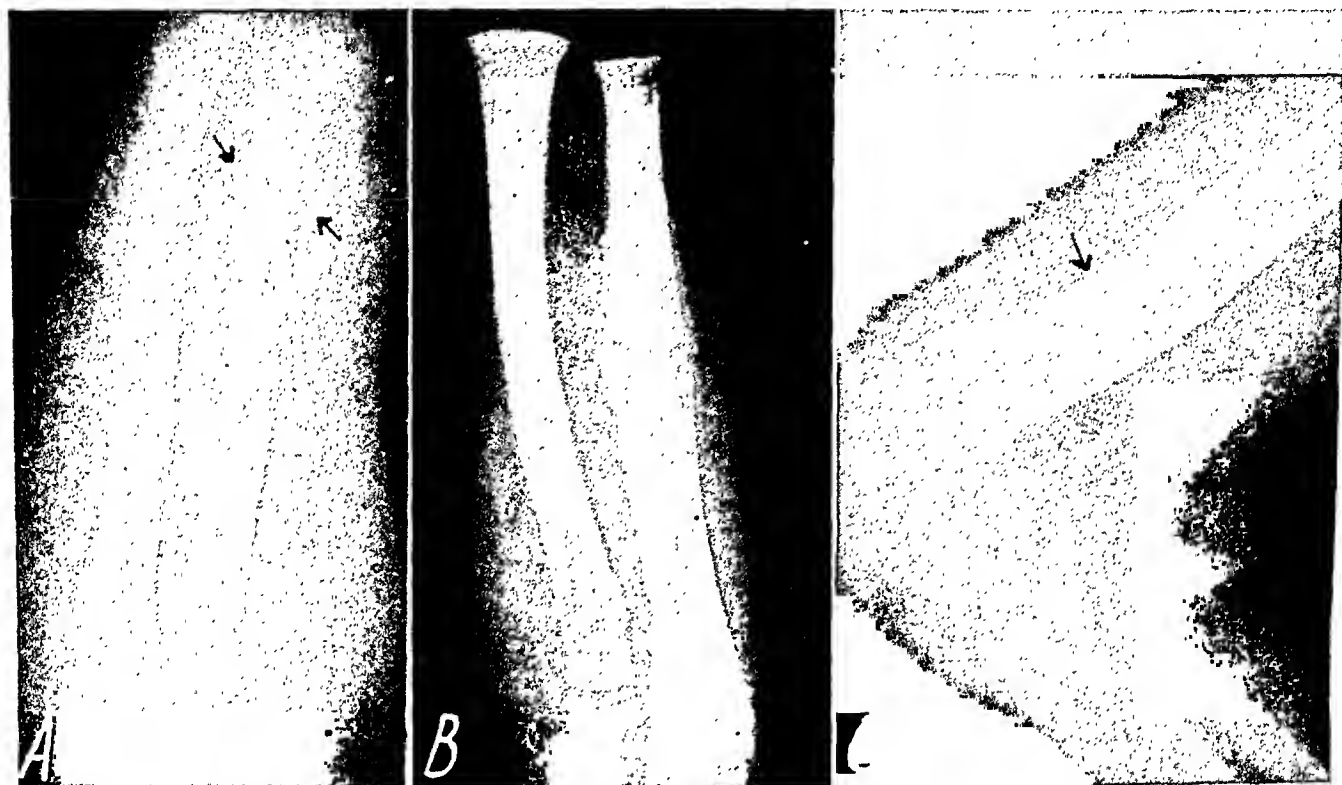


FIG. 1. Case I. Roentgenogram at nine months, two months after the onset of subdural hematoma. (A) Fresh fracture of the right radius. (B) Old fracture of the left ulna. (C) Old fracture of the right femur with angular deformity. There are no roentgen signs of scurvy. The roentgen evidence suggests that the fractures are traumatic rather than pathological.

fresh fracture of the right radius and old fractures of the left ulna and the right femur (Fig. 1). The fractured bones were well developed and well mineralized; there were no roentgen signs of scurvy. The fractured radius healed promptly and at three and one-half years the patient appeared to be normal showing no sequels of the subdural hematoma or the multiple fractures.

CASE II. J. M., a white male born after normal gestation and labor on September 11, 1931, weighed $6\frac{1}{2}$ pounds. Two blood transfusions were given during the neonatal period for the treatment of hemorrhagic disease of the newly born. He was breast fed for one month and then

during the three months prior to the onset of these hemorrhagic manifestations.

A few weeks later during the tenth month the infant suddenly became cyanotic and rigid and remained so for one-half hour. Examination at this time in another hospital disclosed scattered petechiae in the oral mucous membrane and ecchymoses on the skin of the face, arms and trunk. The left side of the face and the left arm were weak. Numerous hemorrhages were found in the ocular fundi. The subdural space was aspirated through the left side of the anterior fontanel and yielded bloody fluid. At this time the clotting and bleeding times of the blood were normal and the blood platelets were nor-

mal in number. Hematuria was not demonstrated in several examinations of the urine. Roentgen examination of the extremities was said to have shown some osteoporosis but no changes diagnostic of scurvy and no fractures.

After discharge from the first hospital convulsions recurred frequently at home, often three and four times daily, until the fifteenth month when he was admitted to a second hospital. In examinations there the patient appeared to be undernourished and pale and there were

which was said to have appeared suddenly without injury, four days previously on the same day that he had been discharged from the hospital. After re-admission the left leg was found to be hot, swollen and tender from the thigh to the ankle. There were purpuric patches on the skin over the left knee and ankle. Roentgen examination disclosed swelling of the soft parts of the left leg but no signs of scurvy or fracture in the bones (Fig. 2*A*). Two weeks later a shell of ectopic subperiosteal bone had

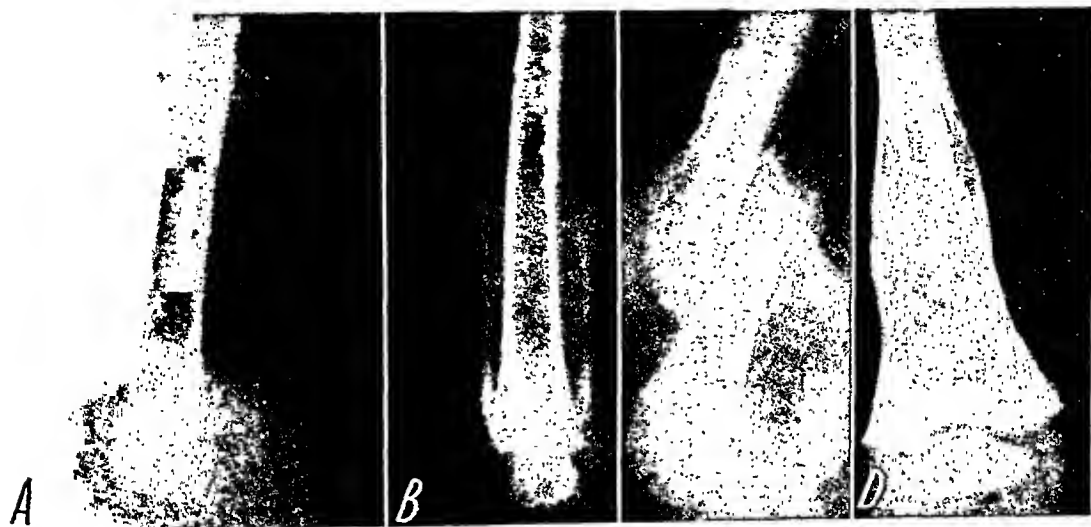


FIG. 2. Case II. (*A*) Lateral projection of the left leg at sixteen months of age, six months after the onset of subdural hematoma. The soft tissues of the thigh are swollen but there is no evidence of a fracture line or scorbutic changes in the bones. (*B*) Two weeks later than (*A*): a shell of cortical bone now surrounds the shaft of the femur with no evidence of a fracture line. (*C*) Lateral projection of the left femur at twenty-two months of age; a complete fracture of the femoral shaft is now present and the overriding fragments are imbedded in heavily mineralized callus. (*D*) Frontal projection of the left femur at twenty-seven months of age; healing of the fracture is more complete but there is still considerable deformity of the shaft.

numerous old ecchymoses on the head and thighs. The anterior fontanel was still widely open and mental development was retarded. The ocular fundi were normal. The bleeding and clotting times were not increased and there were 135,000 platelets per cu. mm. of blood. Fluid, withdrawn from the lumbar subarachnoid space, was yellow and contained 136 erythrocytes per cu. mm. In pneumograms of the skull the lateral ventricles were dilated and asymmetrical and the cranial sutures were widened. The blood Wassermann test gave a nonsyphilitic reaction. After a hospital residence of one month the patient was discharged improved.

After only four days at home and at sixteen months of age, the infant was returned to the hospital because of tenderness of the left leg

formed around the lower three-quarters of the shaft of the left femur but there was still no evidence of fracture (Fig. 2*B*).

At nineteen months of age he was re-admitted to the same hospital because of difficulty in moving arms and legs. The skull was trephined and the diagnosis of subdural hematoma was confirmed.

Convulsions recurred at twenty-two months and the left arm became partially paralyzed at the shoulder. Roentgen examination of the long bones showed a complete fracture in the lower third of the left femoral shaft with overriding of the fragments and a large mass of heavily mineralized callus (Fig. 2*C*). At the proximal ends of both humeri subperiosteal shells of bone surrounded the terminal segments of the shafts. There were no roentgenologic signs of

healed or fresh scurvy in the metaphyses.

At twenty-seven months the patient was admitted for the first time to the Babies Hospital. The head was enlarged and there was limitation of movement of the extremities, more pronounced on the right side. The ocular fundi were pale. Examination of the blood, urine and cerebrospinal fluid resulted in normal findings. Pneumograms of the brain disclosed marked dilatation of the ventricular system; there was no evidence of cranial fracture. In roentgenograms of the extremities the left femur was found to be thickened and deformed at the site of the earlier fracture (Fig. 2D). The distal end of the left humerus was fragmented and surrounded by externally thickened cortex and the shaft of the left ulna was cloaked in heavy cortical layers. The findings in the right humerus were similar to those at twenty-two months but there was a fresh fracture of the distal end of the right ulna with slight angulation.

CASE III. J. B., a female Negro, was born March 10, 1933, after a normal pregnancy and labor. The birth weight was $5\frac{1}{2}$ pounds. She was fed from the breast for two months after which a bottle was given with daily cod liver oil and orange juice. She developed normally.

At eight months she had a generalized convulsion and remained unconscious for several hours. After admission to another hospital two convulsions occurred during a residence there of six days. Convulsive seizures recurred at home, after four days the patient was brought to the Babies Hospital. She was found to be poorly nourished (6.7 kilograms) and short (70 cm.) with large head (43 cm. in circumference). The fontanel was not bulging and there were no signs of meningeal irritation. Multiple fresh hemorrhages were seen in each ocular fundus. Bloody fluid under increased pressure spurted from the needle inserted into the lumbar spine; this fluid was yellow after centrifugation. Subdural punctures on both sides of the anterior fontanel yielded blood-tinged fluid which remained yellow after centrifugation. Kahn's test on the blood and cerebrospinal fluid resulted in nonsyphilitic reactions. The urine was free of blood in several examinations. Subdural fluid was withdrawn at weekly intervals in the hospital and although the fluid remained blood tinged, the patient became brighter and more active. After one month the infant was discharged.

Four days later the mother brought the baby back to the hospital because the right leg had suddenly become tender and swollen and bruises had appeared under the left eye and in other parts of the body. The mother denied that any injury had occurred during the four days since discharge from the hospital. Movement in both lower extremities was found to be limited and the right leg was swollen and tender. There was a large ecchymosis on the left side of the face just beneath the orbit and numerous petechiae were scattered on the abdominal wall. Several fresh hemorrhagic foci were found in the ocular fundi. Lumbar subarachnoid fluid and subdural fluid, withdrawn from the lateral angles of the anterior fontanel, were discolored with blood. Roentgenograms of the extremities disclosed that the bones in the arms were normal but five fractures were visible in the shafts of the bones adjacent to the knee joints—one in the distal end of each femur, one in the proximal end of each tibia and one in the right fibula (Fig. 3). These bones were well mineralized and there were no signs of scurvy in the shafts, the metaphyses or in the epiphyseal ossification centers. In roentgenograms made eighteen days later heavy cortical thickenings surrounded the fractured shafts. The skull was not examined roentgenographically.

The patient remained in the hospital twenty-five days. The swelling and tenderness gradually subsided and disappeared. There were no later observations.

CASE IV. R. M. S., female, was born December 3, 1942, after a normal gestation and labor; she weighed $6\frac{1}{2}$ pounds.

Convulsions began at one month of age and recurred frequently thereafter. A "blood clot," presumably a subdural hematoma, was removed from the cranial cavity during the sixth month at another hospital. Following the operation the convulsions ceased and the vision seemed to improve.

At twelve months pain and tenderness were first noted in the left arm; these manifestations disappeared after two weeks and they did not recur. The mother stated that injury had not occurred at any time. Examination at another clinic disclosed that the movements of the left arm were limited and painful. The left arm was swollen above the elbow and extension of the elbow was limited to 165 degrees; flexion was normal. Pronation and supination were limited to 20 degrees.

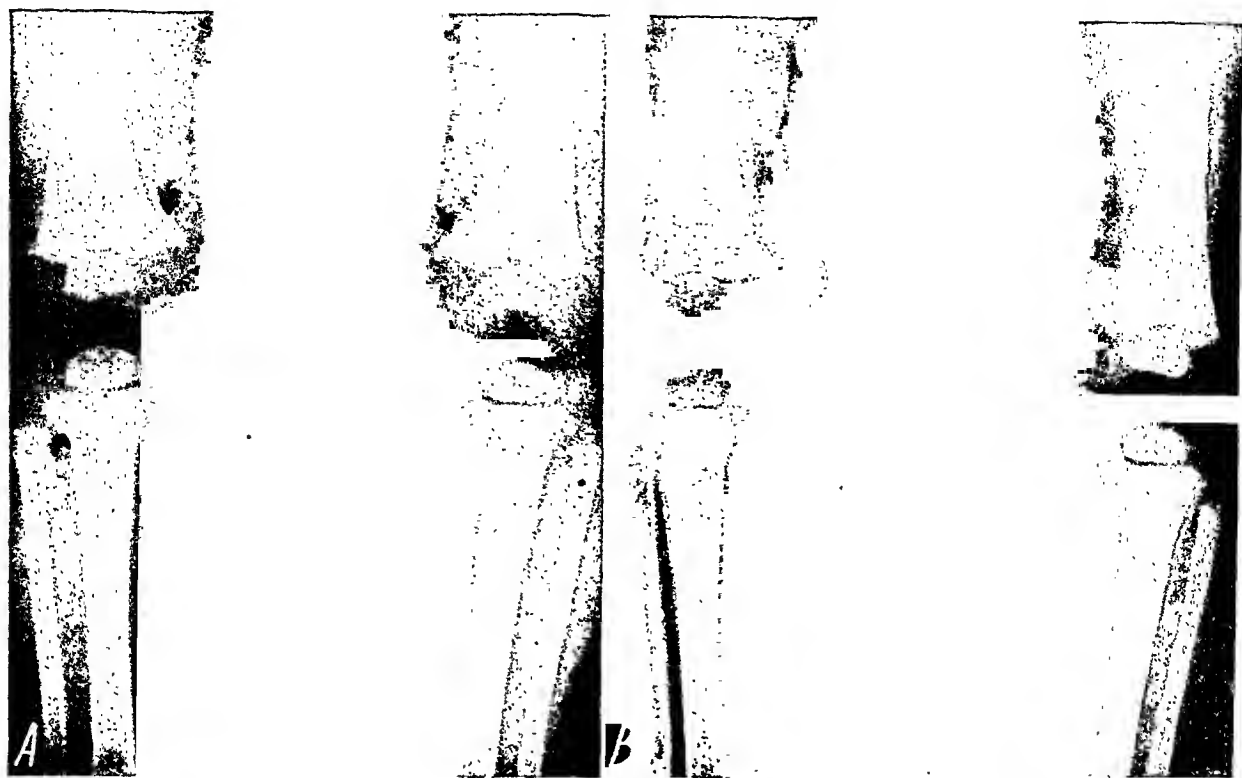


FIG. 3. Case III. (A) Multiple fresh fractures at nine months of age; six weeks after the onset of subdural hematoma. There are transverse impacted fractures in the ends of the right femur, right tibia and right fibula. Small fracture fragments are visible on the medial aspects of the ends of the left femur and tibia. There are no signs of scurvy. (B) This roentgenogram, made eighteen days after (A), shows the cortical thickenings which have developed in the sites of the fractures.

The patient had resided in hospitals during most of the first year and presumably had received a normal diet with adequate vitamin C. Development was retarded. She failed to sit up or stand alone during the first fifteen months of life.

At fifteen months of age she was admitted to the Babies Hospital for the first time when she appeared well nourished. There was a long, healed surgical scar in the scalp; the left arm was flexed at the elbow and hung motionless except when touched. Both active and passive movements of the left arm were painful. Microscopic and chemical examinations of the blood and urine were normal. Kline's test on the blood gave a nonsyphilitic reaction. Clear cerebrospinal fluid withdrawn from the lumbar spine, was normal microscopically and chemically. The ocular fundi were pale.

In pneumograms of the skull the cerebral ventricular system was found to be dilated and there was considerable irregularity in the density of the parietal bones in the sites of earlier craniotomies which were done during the sixth month of life. Roentgenograms of the long

bones disclosed cortical thickenings in both humeri. At the proximal end of the right humerus there was a deformity with displacement of a terminal diaphyseal fracture fragment and its attached epiphyseal centers (Fig. 4). In contrast, only the distal end of the left humerus was thickened. In the distal end of the right tibia there was an old transverse metaphyseal fracture with thickenings of the cortex and displacement of the distal fracture fragment and its attached epiphysis. There were no changes suggestive of old or recent scurvy or rickets.

Following discharge from the hospital the patient did not return for follow-up observations.

CASE V. M. C., male, was born September 4, 1936, after a normal pregnancy and labor; the birth weight was 7 pounds. He thrived on breast milk until the fifth week when he suddenly became weak and dyspneic and remained so for three days when a single convulsion occurred. No injury was observed prior to the onset of these complaints. A few hours after the convulsion he was admitted to the Babies Hospital

and was found to be somnolent but hyper-irritable when disturbed. Respirations were irregular. The anterior fontanel protruded but the neck was not stiff and there were no signs of meningeal irritation. Subdural fluid withdrawn from the left side of the anterior fontanel

sides of the anterior fontanel. There were no hemorrhages in the ocular fundi. Roentgenograms of the cranium revealed widening of the great sutures, and thinning and osteoporosis of the calvarium but no fractures were visible. The extremities appeared to be normal clini-

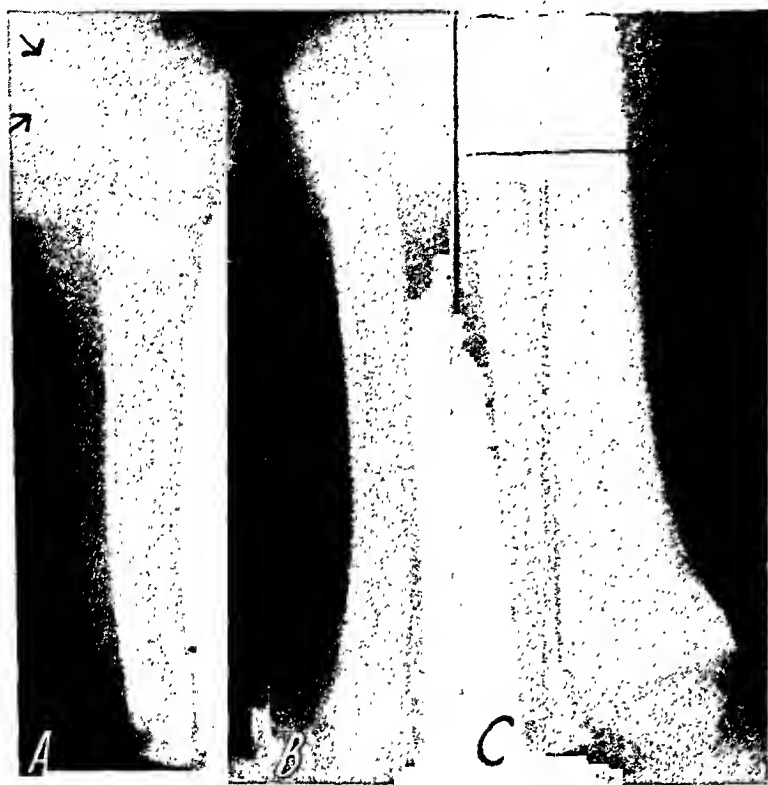


FIG. 4



FIG. 5

FIG. 4. Case IV. Multiple healing fractures at fifteen months of age—fourteen months after the onset of subdural hematoma and three months after the appearance of pain and limitation of movement in the extremities. (A) Cortical thickening and deformity of the proximal end of the right humerus with displacement of the epiphysis and attached diaphyseal terminal fragment. (B) Lamellated thickening of the distal end of the left humerus. (C) Cortical thickening of the distal end of the right tibia.

FIG. 5. Case V. (A) Fresh spiral complete fracture of the femur at seven months of age, six months after the onset of subdural hematoma. (B) Healed fractures and angular deformities in the radius and ulna at seven months of age; there was also a fresh impacted fracture of the proximal end of the humerus. There are no roentgen signs of scurvy in the metaphyses and epiphyses. The fractures in the radius and ulna are old and possibly occurred during the same traumatic episode which caused the subdural hematoma in the first month of life.

was blood tinged as was subarachnoid fluid obtained from the lumbar spine. The patient became more alert after these punctures although the fontanel remained full and the sutures became widened. He vomited irregularly.

At two and one-half months the cranial circumference measured 42 cm. Bloody subdural fluid was obtained in aspirations from both

cally; roentgenograms of them were not made.

At five and one-half months the patient was re-admitted for two weeks with bilateral purulent otitis media. No abnormalities of the extremities were noted in the physical examination.

The patient re-entered the hospital at seven months of age. Six days before black and blue spots had appeared on the forehead and face,

Similar spots were observed on the hands, feet and back on the day of admission. Six hours before admission the left thigh began to swell and the infant cried out with pain when the thigh was touched or attempts were made to move him. The mother denied that the patient had been injured. Orange juice had been started at three months of age and had been taken in daily dosage of approximately 1 ounce.

Scattered ecchymoses were found in the skin of the face and extremities. The left thigh was

were evident in the middle thirds of the right radius and ulna. There were no roentgen signs of old or recent scurvy. In the cranium there were no visible fractures.

The left lower extremity was fixed in traction for five weeks and the femoral fracture healed satisfactorily. The patient was discharged to an institution for chronic care and has not been observed since.

CASE VI. A. L., female, was born on Decem-

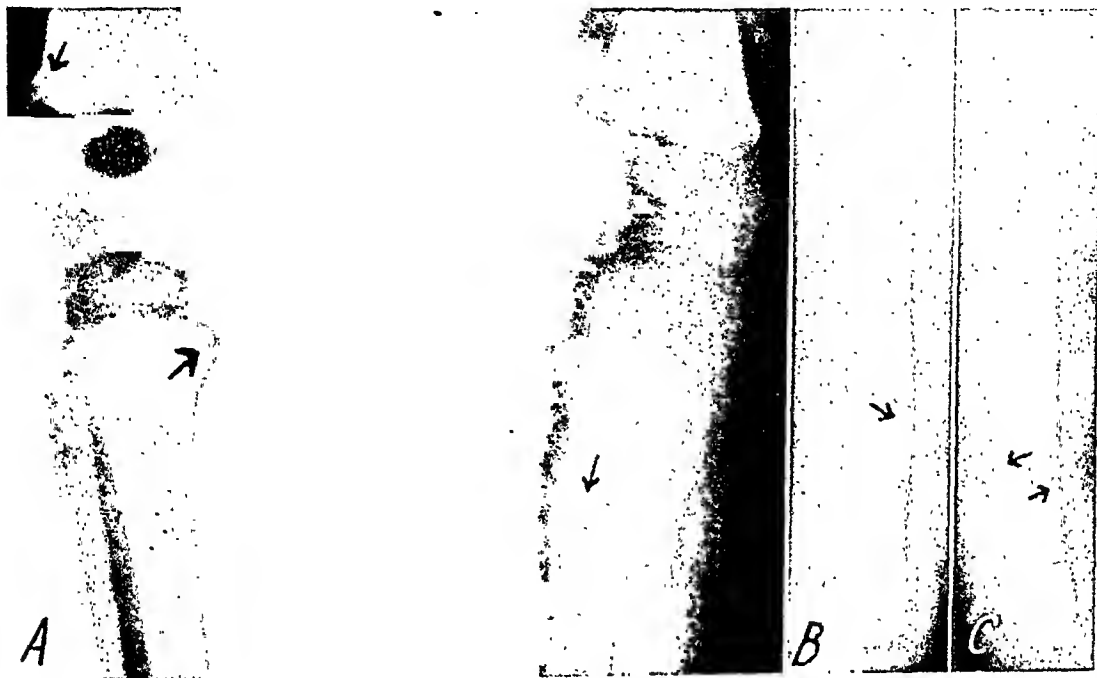


FIG. 6. Case VI. The long bones at six weeks of age. (A) Healing complete fracture of the left tibia and fine fragmentation of the distal end of the right femur and the proximal end of the right tibia. (B) and (C) Delicate subperiosteal thickenings of the humeri. It is probable that all of the skeletal injuries were caused by the same unrecognized causal agent which caused the subdural hematoma. Obstetrical injury is unlikely because the infant was born after cesarean section.

diffusely swollen and tender; it was held in abduction and flexion. There were no hemorrhages in the ocular fundi. Subdural taps on the right and left side of the anterior fontanel yielded blood-tinged fluid. The blood and urine were normal microscopically and chemically; there was no hematuria. The bleeding time was two and one-half minutes; the clotting time was six minutes; there were 490,000 blood platelets per cu. mm. Kahn's test on the blood gave a nonsyphilitic reaction.

Roentgenograms of the extremities disclosed a fresh, long, spiral fracture of the left femur and an impacted fracture in the proximal metaphysis of the right humerus. Old healed fractures with angular deformities (Fig. 5) also

ber 6, 1942, after cesarean section. She weighed 6 pounds. During the first two weeks she appeared to be normal and suffered no recognized injuries.

Convulsions and projectile vomiting began at the end of the second week. Thereafter convulsions recurred frequently, often as many as four times daily.

During the sixth week the mother noted that the infant's left leg was limp and tender. Injury to the baby was specifically denied; only the mother had cared for the infant. The head was large and measured 17 cm. in circumference. The anterior fontanel was large, full and tense. Both eyes showed proptosis and the vision appeared to be poor. Forty-five cubic centi-

meters of bloody subdural fluid was withdrawn from the right side of the anterior fontanel and 15 cc. from the left side. This fluid was yellow after centrifugation. Roentgenograms of the extremities showed a partially healed, complete transverse fracture of the left tibia and fine fragmentation of the distal end of the right femur and the proximal end of the right tibia (Fig. 6). Delicate layers of subperiosteal bone overlay the external surfaces of the humeri. There were no roentgen signs of scurvy and no hematuria. In roentgenograms of the skull the sutures were widened but there were no fractures. The bones of the thorax and pelvis were normal.

Subdural fluid was withdrawn in large amounts in repeated aspirations and at ten weeks a subdural hematoma was removed after

craniotomy. The postoperative course was satisfactory. The patient returned to the care of her private physician.

COMMENT

The skeletal changes are summarized in Table I and their distribution is depicted schematically in Figure 7. In the aggregate all of the large bones in the upper and lower extremities were fractured but the small bones of the hands, feet, wrists and ankles were not affected. The epiphyseal ossification centers were all intact and fractures were not found in the cranium or in the flat bones of the pelvis and shoulder girdle.

Save for the fractures, the entire skele-

TABLE I
SUMMARY OF IMPORTANT DATA IN SIX CASES

Case Number	Bones Affected	Total Lesions	Fractures	Con-tusions	Location Fracture		Follow-ing Sub-dural Hema-toma	His-tory Trauma	Remarks
					Meta-physeal	Dia-physeal			
I	Radius Ulna Femur	3	3	0	0	3	1	0	Fracture of radius during hospital residence without recognized injury
II	Femur Humerus (2) Ulna (2)	5	4	1	2	2	5	0	Skeleton normal roentgenographically at onset of subdural hematoma
III	Femurs (2) Tibias (2) Fibulas	5	5	0	5	0	5	0	All fractures located in opposing bones at knee joint
IV	Humerus (2) Tibia (2)	4	3	1	3	0	4	0	Clinical signs of fracture appeared 11 months after first convulsion
V	Femur Tibia Radius Ulna	4	4	0	1	3	2	0	Fractures of radius and ulna probably neonatal; fractures of humerus and femur occurred at 7 months of age
VI	Humerus (2) Tibia (2) Femur	6	4	2	3	1	0	0	Cesarean section; first convulsion in second week of life
TOTAL	26	27	23	4	14	9	17	0	

tons of all patients appeared to be healthy; this was true of the fractured as well as the unfractured bones. There was neither clini-

The large cortical thickenings associated with several of the fractures (see Fig. 2*B* and 3*B*) are similar to the cortical thickenings which develop in many cases of scurvy following subperiosteal hemorrhage. The other roentgen signs which characterize

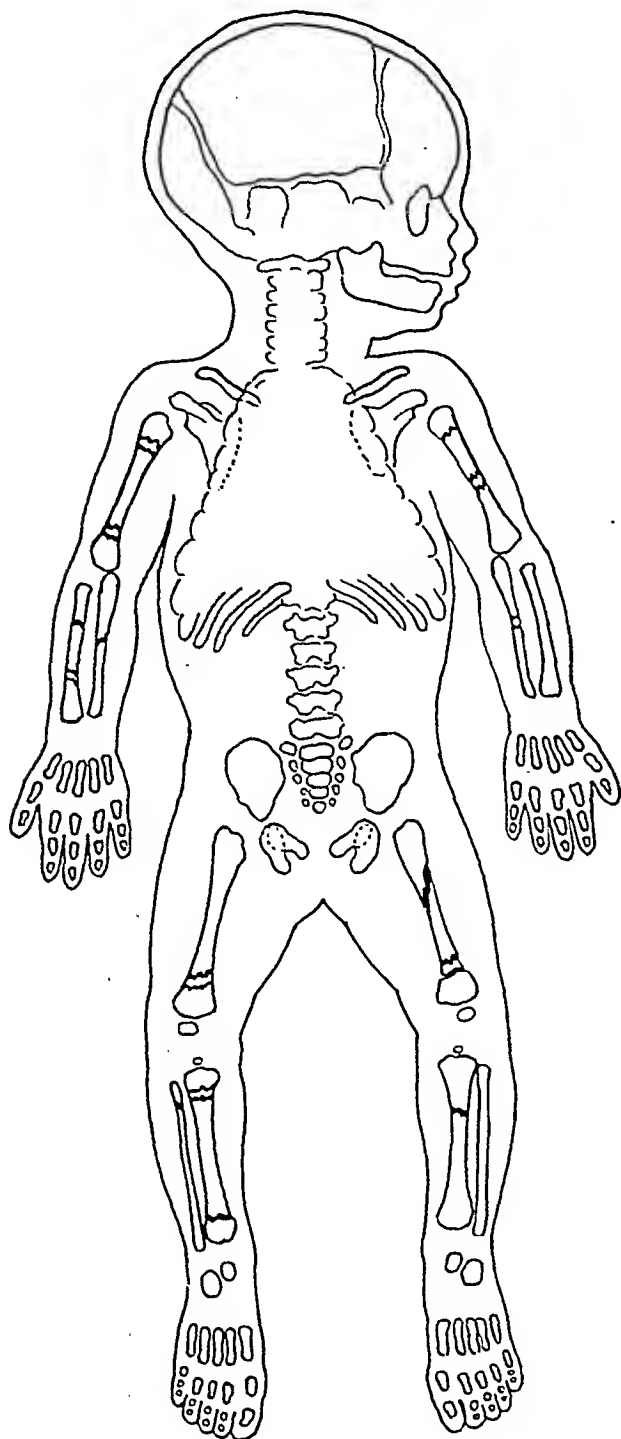


FIG. 7. Spot map of the skeleton showing the distribution of the 23 fractures in 6 patients.

cal nor roentgen evidence to support the idea that pre-existing systemic or localized skeletal disease weakened the bones and made them unusually vulnerable to trauma.

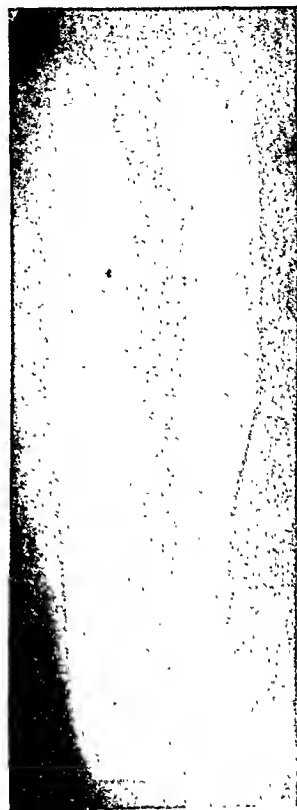


FIG. 8. Traumatic cortical thickening of the radius and ulna following an injury to an infant four and one-half months of age who had neither subdural hematoma nor scurvy. Orange juice had been taken in daily dosages of 2 ounces since the first weeks of life. In the original history the mother stated that the infant's forearm had suddenly become swollen one month before without precedent injury. After the demonstration of the roentgen findings she admitted that a few hours before the onset of the swelling of the forearm, the baby had rolled off a table and she had grabbed him by the left forearm and jerked him into the air to prevent his fall to the floor.

active scurvy are, however, conspicuously absent in these cases—changes in the metaphyses, spongiosa, corticalis and epiphyseal ossification centers. Moreover 5 patients (except Case 1) appeared to have taken adequate vitamin C at the time fractures were found and none of them exhibited the clinical manifestations of active

scurvy. During the first years of life when the periosteum is normally loosely attached to the underlying corticalis and is normally richly supplied with blood vessels, large subperiosteal hemorrhages commonly develop at the sites of traumatic fractures in nonscorbutic infants (Fig. 8). Two other features make the scorbutic origin of the fractures highly improbable. Nine of the fractures were located deep in the shafts (see ulna, Case I; femur, Case II; femur, Case V; tibia Case VI); scorbutic fractures in contrast develop characteristically in the metaphyses near the cartilage-shaft junctions. Furthermore angular deformities of the fractured bones persisted after healing in several bones (see femur, Case I; femur, Case II; humerus, Case IV; radius and ulna, Case V). Scorbutic fractures in our experience heal without residual angular deformities. Although scurvy has been described in a few cases of infantile subdural hematoma,^{4,5} there is no convincing clinical or roentgen evidence that the patients in this group suffered from vitamin C deficiency.

When cortical thickenings were demonstrated in the absence of visible fractures, the lesions have been classified as periosteal contusions (see left humerus, Case IV and both humeri, Case V). Trauma to the periosteal blood vessels may cause subperiosteal hemorrhage, elevation of the periosteum, and local cortical thickening in nonscorbutic infants (see Fig. 8). The causal mechanism is similar to that of traumatic ossifying periostitis of the newly born.⁶ It is also possible that fractures were actually present in the sites of the cortical thickenings but were invisible roentgenographically. Such was undoubtedly the case in the femur of our second patient. In an early roentgenogram (Fig. 2B) a large subperiosteal swelling was visible but there was no evidence of a fracture line; six months later however (Fig. 2C), at the same site a healed complete fracture, overriding of the fragments and massive callus were all evident.

The traumatic theory of the causation of

subdural hematoma has been accepted almost to the exclusion of all other causes⁷ despite the fact that a history of injury is lacking in almost one-half of the cases.⁸ The negative history of trauma in so many cases can probably be best explained by assuming that sometimes lay observers do not properly evaluate ordinary but causally significant accidents especially falls on the head, and that other important traumatic episodes pass unnoticed or are forgotten by the time delayed cranial symptoms appear. Putman and Cushing⁹ have pointed out that weeks or months may elapse between the original cephalic injury and the onset of the clinical signs of subdural hematoma. Also recognized injuries may be denied by mothers and nurses because injury to an infant implies negligence on the part of its caretaker.

The absence of history of trauma to the fractured bones cannot be explained in the same way. The injuries which caused the fractures in the long bones of these patients were either not observed or were denied when observed. The motive for denial has not been established. The clinical signs of fractures in the long bones usually appear immediately after injury and the causal relationship between the traumatic force and damage to the bone is clear. It is unlikely that trivial unrecognizable trauma caused the complete fractures in the femurs in Cases I, II and V; in the humerus in Case IV; and in the radius in Case I. Moreover in several cases ecchymoses were found near the sites of the fractures. There was a striking similarity in the course of events in Case II and Case III. In each case unexplained fresh fractures appeared shortly after the patient had arrived home after discharge from the hospital. In one of these cases the infant was clearly unwanted by both parents and this raised the question of intentional ill-treatment of the infant; the evidence was inadequate to prove or disprove this point. In Case I a fresh complete fracture of the radius with ecchymoses in the neighboring soft tissues developed after a continuous residence of nine days in the

hospital and, notwithstanding, injury was not observed or at least not admitted by the hospital attendants.

It is possible that some of the fractures in the long bones were caused by the same traumatic forces which were presumably responsible for the subdural hematomas. However, this was not the case in the majority of the fractures because 17 fresh fractures appeared many weeks and months after the first clinical manifestations of subdural hematoma and after the withdrawal of bloody fluid from the subdural space. In one patient (Case iv) fractures in the long bones developed six months after the subdural tumor had been removed surgically.

We have also considered the possibility that the long bones were injured and fractured during convulsive seizures. There is little evidence to support such a postulate. In not a single case did fresh fractures appear immediately following the convulsive seizure and complete fractures occurred in patients who had only mild convulsions. It has been demonstrated that the vertebral bodies of children may be fractured during the convulsive seizures of tetanus¹⁰ but in these circumstances there were no associated fractures in the extremities. To our knowledge, fractures of convulsive origin in the long bones have never been demonstrated in the common severe convulsive diseases of infancy and childhood such as lead poisoning, meningitis, cerebral neoplasm and hypocalcemic tetany.

SUMMARY

(1) Six infants with chronic subdural hematoma and associated multiple fractures in the long bones are described.

(2) History of injury to the long bones as well as to the head was lacking in all cases.

(3) There was no roentgen or clinical evidence of general or localized skeletal disease which would have predisposed the bones to pathological fractures.

(4) The majority of the fractures developed after the onset of the subdural hematomas.

CONCLUSIONS

Fractures of the long bones are a common complication of infantile subdural hematoma.

The fractures appear to be of traumatic origin but the traumatic episodes and the causal mechanism remain obscure.

The presence of unexplained fractures in the long bones warrants investigation for subdural hematoma.

Routine roentgen examination of the long bones in subdural hematoma is necessary for the identification of fractures because many of them are silent clinically.

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REFERENCES

1. SHERWOOD, D. Chronic subdural hematoma in infants. *Am. J. Dis. Child.*, 1930, 39, 980.
2. INGRAHAM, F. D., and HEYL, H. L. Subdural hematoma in infancy and childhood. *J. Am. M. Ass.*, 1939, 112, 198-204.
3. INGRAHAM, F. D. Personal communication, May 7, 1945.
4. GILMAN, B. B., and TANZER, R. C. Subdural hematoma in infantile scurvy. *J. Am. M. Ass.*, 1932, 99, 989-991.
5. INGALLS, T. H. The rôle of scurvy in the etiology of chronic subdural hematoma. *New England J. Med.*, 1936, 215, 1279-1281.
6. SNEDECOR, S. T., KNAPP, R. E., and WILSON, H. B. Traumatic ossifying periostitis of the newborn. *Surg., Gynec. & Obst.*, 1935, 61, 385-387.
7. GROFF, R. A., and GRANT, F. C. Chronic subdural hematoma; collective review. *Internat. Abstr. Surg.*, 1942, 74, 9-20.
8. INGRAHAM, F. D., and MATSON, D. D. Subdural hematoma in infancy. *J. Pediat.*, 1945, 24, 1.
9. PUTNAM, T. J., and CUSHING, H. Chronic subdural hematoma. *Arch. Surg.*, 1925, 11, 329-393.
10. DIETRICH, H. F., KARSHNER, R. G., and STEWART, S. F. Tetanus and lesions of the spine in childhood. *J. Bone & Joint Surg.*, 1940, 22, 43-54.



POLYOSTOTIC FIBROUS DYSPLASIA AND OSTEOPATHIA CONDENSANS DISSEMINATA*

CASE REPORT

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OSTEOPATHIA condensans disseminata and polyostotic fibrous dysplasia are clinical entities rarely observed. The opportunity to describe the occurrence of both in the same patient leads to the following case report:

F. G., white male, aged fifteen, of Polish parentage, was first seen in the University of Pennsylvania Hospital in 1931. He was apparently normal until the age of two, when, after a fall, a swelling was first noticed in the occipital region. This swelling gradually increased in size, but there were no associated symptoms.

At seven years of age the patient had an

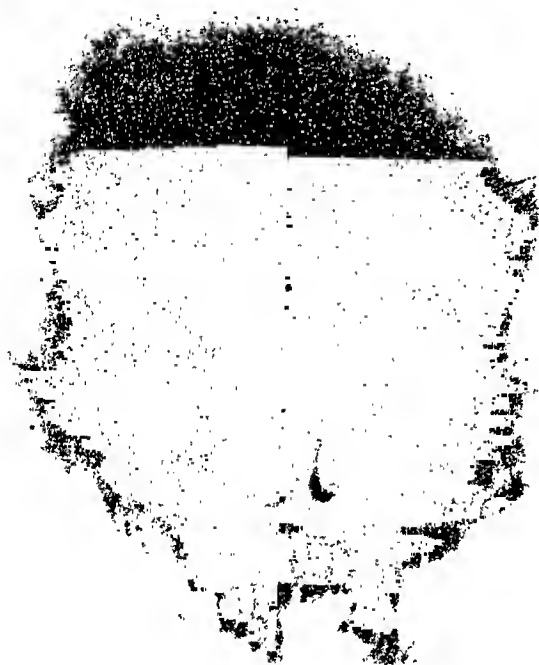


FIG. 1



FIG. 2



FIG. 3

* From the Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania.



FIG. 4

abscess of a left maxillary molar tooth. The infection localized and drained spontaneously. Following this there was noted a progressive deformity of the left side of the face which became more marked as the patient became older.

When eleven years old, the patient sustained a fracture of both bones of the right forearm, which healed without incident. At the age of fourteen the patient was seen in another hospital, where a biopsy specimen of the occipital mass was obtained. The histopathologic diagnosis was osteochondroma.

Shortly before admission the patient was seen in the Dental Clinic of the University of Pennsylvania, where two maxillary and two mandibular molar teeth were removed. Roentgenograms made at that time showed abnormalities of the bones of the jaws.

The patient's parents and six siblings were living and well, and no history of anything suggesting an osseous dystrophy was elicited.

The patient was small in stature. His intel-

ligence was estimated as normal. The head was asymmetrical and large in proportion to the rest of the body. There were marked prominences in the occipital and left frontoparietal areas, and the bones of the left frontal, zygomatic and mandibular regions were prominent, giving the face an asymmetrical appearance. There was a prominence of the right trochanter as compared with the left, a slight genu valgus, and the patient walked with a slight limp. There was no pubic hair, and the left testicle was hypoplastic; otherwise the sexual characteristics were normal. There was no record of any abnormal pigmentation. The remainder of the physical examination was negative.

The blood count was normal and the urine clear and of normal specific gravity. The blood calcium (on separate determinations) was 10.4, 11.3 and 13.3 mg. per 100 cc.; the blood phosphates, 3.7 mg. per 100 cc.

Roentgenograms made at that time show the following:



FIG. 5

Head (Fig. 1 and 2): Multiple areas of fibrocystic disease with scattered areas of increased density, involving the base of the skull and the bones of the vault, especially in the occipital and frontoparietal areas. Similar changes were present in the left mandible and the bones of the left side of the face. The changes were not strictly unilateral although more marked on the left side.

Long Bones (Fig. 3 and 4): Fibrocystic areas in left humerus, right tibia and fibula and right femur with multiple areas of osteopathia condensans in the upper ends of both femora and tibiae, and in the small bones of the hands and wrists.

The spine, chest and ribs were negative.

Pelvis (Fig. 5): Multiple areas of fibrocystic disease and osteopathia condensans in both ilia, with osteopathia condensans in the pubes and ischia. There was marked asymmetry of the pelvic inlet.

Because of the multiple cystic areas and the increased blood calcium, and in spite of the skull changes, which were interpreted as juvenile Paget's disease, exploration of the parathyroids was advised but refused.

The patient was discharged in status quo,

and it was not possible to have him return for follow up, although he was known to have continued in good health.

He was next seen in 1942, at the age of twenty-six, at an induction center. He had continued to be in good health, and had had no fractures, although the deformity of the head and face had progressively increased. Follow up roentgenograms at this time were permitted, but no other studies could be arranged.

These roentgenograms showed a marked increase in the disease in the bones of the head and face, although the character of the changes was the same (Fig. 6 and 7). The fibrocystic areas in the pelvis (Fig. 8) were much larger and more widely disseminated, as were those in the upper end of the right femur where there was evidence of incomplete fracture. The areas of the osteopathia condensans were more numerous and of greater size and density.

New sections from the biopsy specimen of 1930 were obtained through the courtesy of Dr. John Howard of the Misericordia Hospital. These were described by Dr. Robert C. Horn, Surgical Pathologist, University of Pennsylvania Hospital, as showing "a loose fibrous matrix containing many spindle cells and irregular bony trabeculae. A few of the trabeculae



FIG. 6

resembled osteoid tissue, suggesting that the bone had been formed directly in the fibrous tissue." The appearance was thought to be compatible with that of fibrous dysplasia as described by Lichtenstein.

Osteopathia condensans disseminata is considered to be congenital in origin and often familial in occurrence. Its presence in the above patient may therefore be presumed to be congenital; no data are available as to its possible presence in other members of the family. Polyostotic fibrous dysplasia, on the other hand, is said (Lichtenstein) to have no familial incidence and to display no hereditary tendency. Lichtenstein, and others, however, feel that it is congenital in origin. In this patient, the presence of a fibrous dysplasia, already observable at the age of two years, suggests an even earlier origin. The probability of its congenital origin is strengthened by the presence of another abnormality of bone growth, admittedly congenital, osteopathia condensans disseminata. The latter condition has been described in association with another congenital lesion, coarctation of the aorta (Phalen and Ghormley). Polyostotic fibrous dysplasia has been reported by Stauffer *et al.* in association with congenital arteriovenous aneurysms. It is well recognized that congenital variations in development are often multiple.

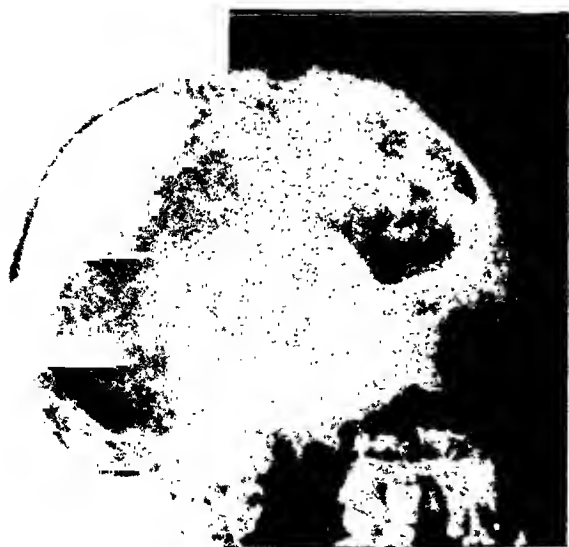


FIG. 7



FIG. 8

In general, the features presented by the above case are not unusual. During an eleven year period of observation the roentgen appearance of the lesions of osteopathia condensans disseminata had varied little from that ascribed to the condition by previous observers, and again, no symptoms attributable to the lesions were manifest. While the fibrocystic areas had increased in size, no new areas of involvement appeared, and except that no manifest fractures had occurred, the progress of this condition, too, was that of previously described cases, and no symptoms were produced. In spite of the fact that some areas were involved by both processes, no changes in the course of one were noted which seemed to be in any way related to the presence of the other.

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REFERENCES

1. ETTER, L. E., and HURST, J. W. Polyostotic fibrous dysplasia. *Radiology*, 1943, 41, 70-74.
2. FURST, N. J., and SHAPIRO, R. Polyostotic fibrous dysplasia; review of the literature with two additional cases. *Radiology*, 1943, 40, 501-515.
3. HINSON, A. Familial osteopoikilosis. *Am. J. Surg.*, 1939, 45, 566-573.
4. KELLOGG, D. S., and LINSMAN, J. F. Osteopathia

- condensans disseminata. *Southwestern Med.*, 1942, 26, 44-47.
5. LICHTENSTEIN, L. Polyostotic fibrous dysplasia. *Arch. Surg.*, 1938, 36, 874-898.
6. MALLORY, T. B. Medical progress; pathology, diseases of bone. *New England J. Med.*, 1942, 227, 955-960.
7. McLEAN, E. H. Osteopoikilosis; disseminated osteosclerosis. *Northwest Med.*, 1942, 41, 92-93.
8. PHALEN, G. S., and GHORMLEY, R. K. Osteopathia condensans disseminata associated with coarctation of the aorta. *J. Bone & Joint Surg.*, 1943, 25, 693-700.
9. STAUFFER, H. M., ARBUCKLE, R. K., and AEGERTER, E. E. Polyostotic fibrous dysplasia with cutaneous pigmentation and congenital arteriovenous aneurysms. *J. Bone & Joint Surg.*, 1941, 23, 323-334.
10. STEENHUIS, D. J. About a special case of otitis condensans disseminata. *Acta radiol.*, 1926, 5, 373-374. Discussions by Heilbron and Keyser.



TRAUMATIC PNEUMOCEPHALUS ASSOCIATED WITH CEREBROSPINAL OTORRHEA*

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PNEMOCEPHALUS (intracranial pneumatocele or arocele) associated with cerebrospinal rhinorrhea following fractures in the frontal region is not uncommon^{3,5} and the surgical treatment of this condition when chronic is a well accepted procedure¹ (Fig. 1). However, the presence of intraventricular air resulting from middle cranial fossa fractures associated with cerebrospinal otorrhea is relatively uncommon. Worms, Didiée and Grumbach⁷ collected 72 cases of intracranial pneumatocele from the literature and added a case of their own to the series. There were 3 cases in which the entrance of air into the intracranial cavity occurred as sequels of operations on the nose or mastoid sinus; 2 followed infections of the frontal or ethmoidal sinuses, and 1 occurred in association with an osteoma of the orbit.* The remaining cases were associated with skull fractures or bullet (or grenade) wounds of the skull. There were 10 cases in which the air entered the cranial chamber from the mastoid air sinuses or the ear; in 5 cases, otorrhea occurred, and the air was intraventricular. Operation for repair of the dural defect, such as practiced in cases of anterior fossa fractures with pneumo-

cephalus and rhinorrhea was not done in any of the 10 patients, but 1 of them died. In the 1 mortality (Case II⁵), necropsy revealed that there was a fistula between a large left temporal lobe abscess and the descending horn of the left lateral ventricle. It was Dandy's belief that the air was forced through the mastoid defect (produced by previous operation) into the abscess cavity by sneezing, coughing, or swallowing. Barden² recorded 2 cases in which air gained access to the intracranial subdural space following basal skull fractures.

The case which we are reporting is rather unusual in that necropsy excluded the possibility of direct entrance of air from mastoid cells or ear to the ventricular system and established the fact that the gas must have taken a circuitous route through the subarachnoid space to the ventricles by way of normal channels.

L.C., male, aged fifty-seven, fell down a flight of stairs on March 3, 1945, and was unconscious for an uncertain length of time. On admission to the hospital, he was quite alert and appeared normal. A discharge of clear serous fluid from the left external auditory canal was noted two days after the accident, and this ceased on the following day. Immediately after the appearance of the cerebrospinal otorrhea, the patient was given 2 grams of sulfadiazine and 2 grams of sodium bicarbonate by mouth every four hours for one day, and 1 gram of each drug every four hours thereafter. Roentgenograms of the skull showed gas in the ventricular system (Fig. 3) with evidence of a fracture line in the left temporal region extending into the base of the middle fossa. On March 11, 1945, he suddenly became confused, drowsy, and developed a paralysis of the entire left side of the face. A lumbar puncture was done, and 10 cc. of cloudy cerebrospinal fluid was

* Two of these relatively rare cases of intracranial pneumatocele occurring in association with orbito-ethmoidal osteomas have been described by Cushing.⁴ The intracranial collection of air is the result of erosion of the ethmoidal or frontal sinus by the tumor. One of us (I.M.T.) with Dr. L. M. Davidoff operated upon such a case at the Jewish Hospital of Brooklyn (Fig. 2). The man, aged thirty-two developed a right frontal headache and left hemiparesis rather suddenly one week before hospitalization. This headache was intensified by sneezing which occurred frequently since he suffered from hay fever. At operation, the cortex and dura were found to be very tense. A needle was introduced into the frontal cortex, and at a depth of less than 2 cm. a large puff of air escaped from the needle, and the dura became quite relaxed. The rent in the dura over the perforated sinus (frontal or ethmoidal) was repaired by a graft taken from the fascia lata and sutured to the margins of the dura. Motor power in the upper extremity returned to normal the day after operation, recovery of lower limb function requiring several months.

* From the Department of Neurosurgery of the New York Medical College, Flower and Fifth Avenue Hospital and the Metropolitan Hospital, New York.

removed. The fluid contained 26,000 white blood cells per cubic millimeter, and the cells were mostly polymorphonuclear leukocytes. The patient was given 20,000 units of penicillin intrathecally and 10,000 units intramuscularly every three hours. In addition, 2.5 grams of sodium sulfadiazine were administered intravenously. In spite of continued treat-

ment with penicillin and sodium sulfadiazine of approximately the same dosages as received initially, the patient died on March 15, 1945, twelve days after the accident. Blood sulfadiazine levels were 8.52 mg. per 100 cc. combined of which 7.31 was free drug on March 9; 6.4 mg. per 100 cc. combined and 5.62 mg. per 100 cc. free sulfadiazine on March 12, and 4.58 mg.

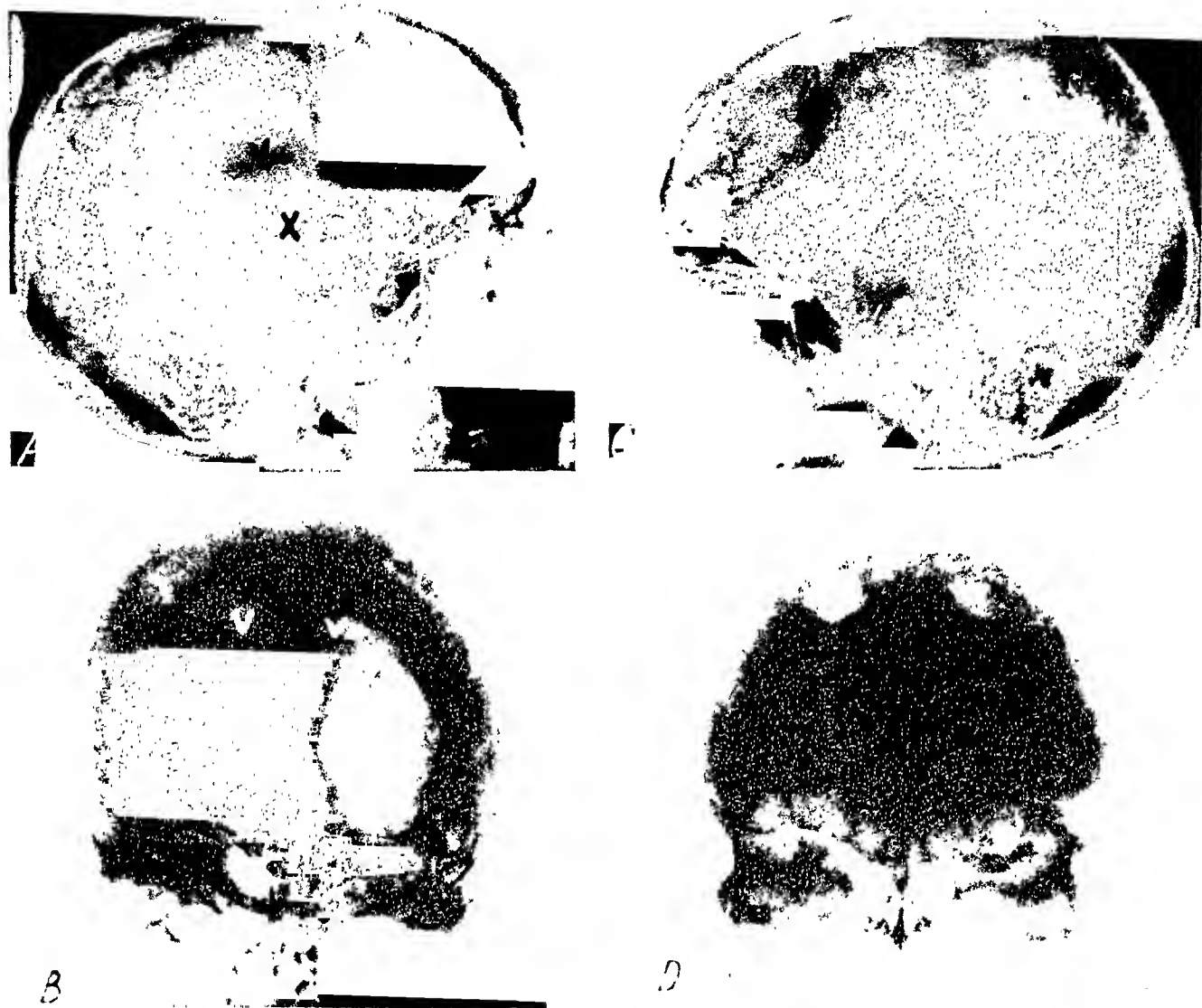


FIG. 1. Roentgenograms demonstrating air in the ventricle (v) and in a traumatic porencephalic defect (P). The extensive fracture line is seen crossing the frontal sinus. The bony defect (x) represents a right subtemporal decompression done six years previously because of "epilepsy." The cerebrospinal rhinorrhea occurred fourteen weeks after the patient sustained his injury following which he was unconscious for ten days. A fluid-air level is seen in the ventricles (A and B) and in the traumatic porencephaly (A).

At operation, a left frontal osteoplastic bone flap which extended to the right of the midline was elevated. A large traumatic porencephalic defect with yellow-stained walls was found in the left frontal lobe. This cavity was filled with fluid and air, and it communicated with the left ventricle and the left frontal sinus. The site of the fistula was readily identified by the attachment of the adjacent cerebral tissue of the inferior surface of the frontal pole to the 2 cm. defect in the dura mater and the frontal sinus. The meningo-cerebral scar was excised and a fascia lata graft interposed. The graft was sutured to the margins of the dural defect. Good recovery followed the operation, and there was complete cessation of the cerebrospinal fluid rhinorrhea. The disappearance of the air in the ventricles and in the porencephalic defect is seen in the postoperative roentgenograms (C and D).

per 100 cc. combined of which 4.06 mg. per 100 cc. was in the free form on March 14. Pneumococcus, Type III, was grown from the cerebrospinal fluid removed on March 11.

Autopsy was performed on March 17, 1945, by Dr. Henry Weinberg, Assistant Medical Examiner of New York, in the presence of Drs.

and depressed, terminating in the left middle ear lateral to the opening of the facial nerve. On being opened, the middle ear (left) shows evidence of greenish fluid, the left ear drum being ruptured. No fractures of any other part of the calvarium including the frontal and ethmoidal sinuses is seen. Green pus covers both cerebral

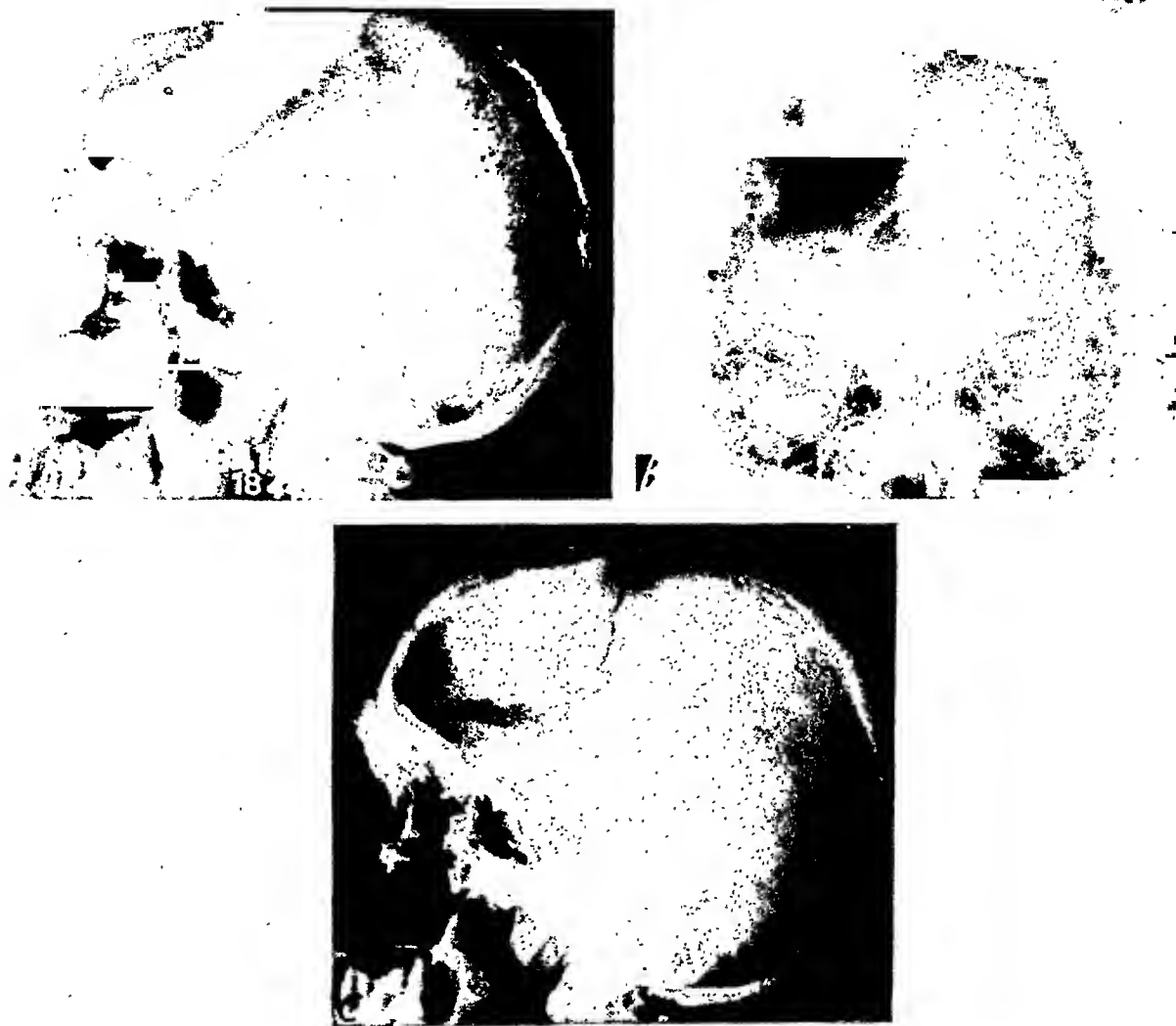


FIG. 2. Roentgenograms showing: *A*, orbito-ethmoidal osteoma associated with intracerebral pneumatocele of the right frontal lobe; *B*, the osteoma is seen occupying the right and to a less extent, the left frontal and ethmoidal sinuses; *C*, postoperative roentgenogram shows absence of the intracranial portion of the osteoma shown in (*A*) and (*B*) with tumor still present within the sinuses. The pneumatocele was evacuated at operation.

Helpern and Vance. The report of the autopsy findings follows:

"There is a hemorrhage in the galea in the left parietal region and one in the left temporal region. The calvarium shows evidence of a comminuted linear fracture of the middle fossa commencing in the left parietal bone, 3 inches above the left external orbital process and extending downwards and backwards $1\frac{1}{2}$ inches where it bifurcates and becomes comminuted

hemispheres especially both frontal and parietal regions with contrecoup laceration of the tip of the right temporal lobe. There was no evidence of any laceration of the tip of the left temporal lobe. The brain on section showed dilatation of the lateral ventricles (slight in degree).

"The anatomical diagnoses were: suppurative leptomeningitis; traumatic fracture left middle fossa extending to the left of the midline; rup-

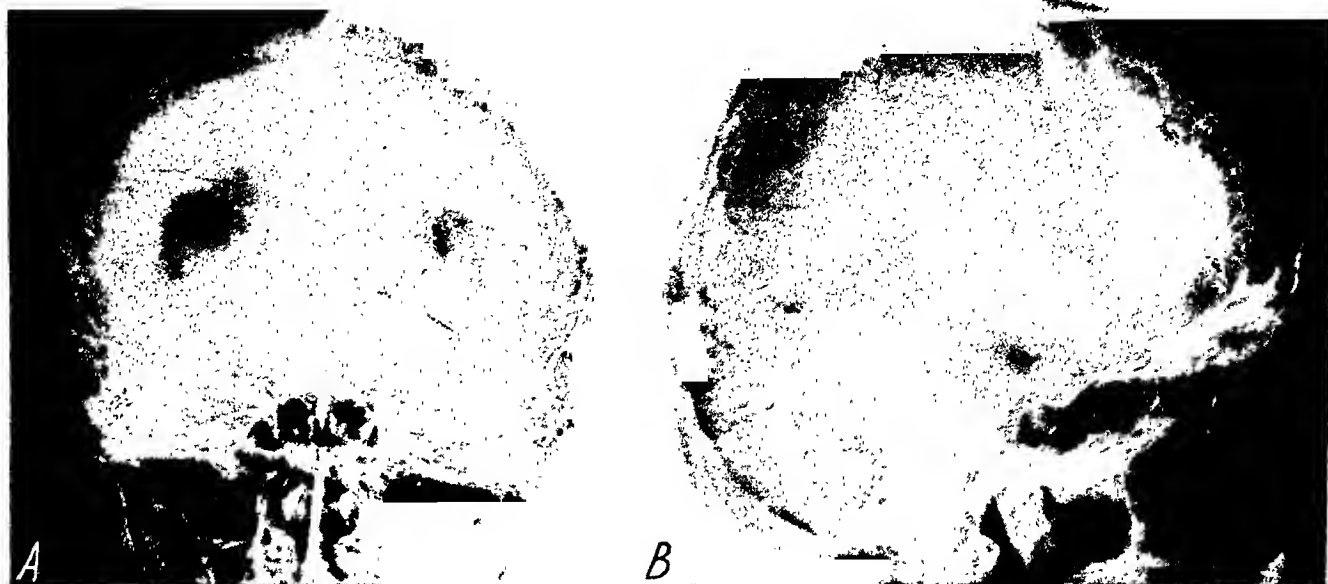


FIG. 3. Roentgenograms showing gas in the lateral ventricles. A linear fracture is seen in the left temporal region extending to the base of the middle fossa and crossing the petrous portion of the temporal bone (B).

tured left ear drum; contrecoup laceration of the tip of the right temporal lobe; generalized atherosclerosis."

In the case illustrated in Figure 1, and successfully treated by operation, air entered the porencephalic cavity from the frontal sinus and from there through the fistulous tract to the ventricle. However, such a direct pathway for the air in our case of cerebrospinal otorrhea is excluded by autopsy findings. The gas must have followed a more circuitous pathway. It might have entered the middle ear cavity by way of the eustachian tube or from the external auditory canal through the ruptured tympanic membrane; on the other hand, it might have come from the mastoid air cells directly. However, from either middle ear or mastoid sinus, the gas traversed the fracture in the petrous portion of the temporal bone. Although a tear in the arachnoid and dura were not seen at autopsy, they doubtless were present when the otorrhea appeared and probably healed subsequently. The air must then have entered the subarachnoid space, the basilar cisterns, and finally the ventricular system through the foramina of Luschka and Magendie. There was no contusion of the temporal lobe on the side of the fracture,

no opening of the floor of the third ventricle, and no other direct pathway from fracture site to ventricular system.

We were quite surprised to find that air was present in the intracranial cavity in this case since the patient had no headache or other complaint during the first week of hospitalization, and he was very anxious at this time to return home. In fact, the cerebrospinal otorrhea was slight and may easily have been overlooked. If the roentgenogram of the skull had been taken on the day of admission and pneumocephalus disclosed, immediate sulfadiazine therapy would have been instituted, rather than two days later when the otorrhea appeared. It seems doubtful that the earlier therapy of sulfadiazine alone would have altered the course of events since the signs of meningitis did not appear until six days after the drug was started. Nevertheless, roentgenographic examination of the skull should be carried out as early as is feasible in cases of head injury and prophylactic therapy for infection started promptly if pneumocephalus is found or if fracture lines communicate with any of the cranial sinuses. The presence of pneumocephalus following an injury even in the absence of cerebrospinal rhinorrhea or otorrhea would in-

dicates that a pathway has been established between the cranial sinuses and the intracranial cavity. However, pneumocephalus may result from "infections of gas producing organisms—*bacillus aerogenes capsulatus* (of Welch) and possibly *colon bacillus*."⁵ In any case, preventive treatment of intracranial infection would be immediately indicated. The appearance of rhinorrhea and pneumocephalus may be delayed for a considerable period of time after injury such as occurred in the case illustrated in Figure 1 in which the interval before appearance of rhinorrhea was fourteen weeks. During this time, disintegration of damaged cerebral tissue with formation of a pencephalic cavity must have occurred. Intervals of days or weeks after injury before symptoms (most commonly headache or other symptoms of increased intracranial pressure) of pneumocephalus developed was recorded in a number of cases collected from the literature.^{5,7} In cases of intracerebral pneumatocele, progressive destruction may occur as a result of the irritating effect and the pressure of the air. This point is illustrated in the case shown in Figure 2 in which hemiparesis appeared rather suddenly together with cerebrospinal rhinorrhea and headache. The onset of these symptoms probably coincided with the rapid entrance of air into the frontal lobe. In view of the symptoms of increased intracranial pressure and the likelihood of progressive destructive effect of the air that is trapped within the cerebral tissue, operation should not be delayed in these cases.

In addition to intracerebral and intraventricular pneumatocele, gas may occur in the subarachnoid and subdural spaces. Dandy has stressed the fact that another factor besides the existence of a pathway from cranial sinuses to cranial chamber which is necessary for the development of pneumocephalus to occur is "increased pressure of air within the cranial sinuses such as is produced by sneezing, coughing, straining or possibly even swallowing." In this connection, it is of interest

that the patient whose roentgenograms are reproduced in Figure 2 suffered from hay fever during which violent sneezing spells occurred. It is probable that this condition precipitated the onset of his symptoms. Dandy has produced evidence to show that a "channel may be patent for fluid and not for air."

Cerebrospinal otorrhea differs from rhinorrhea in that it does not appear to persist. If, however, cerebrospinal otorrhea were persistent, in view of the serious potentiality of intracranial infection which would exist, one would be obliged to undertake operative repair with the use of a facial transplant such as is done in the case of cerebrospinal rhinorrhea.

The mortality rate in untreated cases of pneumocephalus is considered to vary from 40–50 per cent,⁵ infections or increased pressure being the causes of death. With the use of the sulfonamide drugs, the outlook in cases of cerebrospinal rhinorrhea and otorrhea, so far as this dreaded complication of meningitis is concerned, is considered favorable.⁶ However, prophylactic treatment with sulfadiazine was ineffectual in our case in preventing meningitis, just as in combination with penicillin therapy it was of no avail after the infection had appeared. It is possible that large doses of sulfadiazine may have resulted in higher blood levels for the drug and hence prophylactic success. Nevertheless, it would appear to be advisable in cases of cerebrospinal otorrhea or rhinorrhea to use immediately a combined prophylactic treatment of penicillin and sulfadiazine for intracranial infection.

SUMMARY AND CONCLUSION

A case of fracture through the petrous portion of the temporal bone is described in association with cerebrospinal otorrhea and spontaneous pneumocephalus. Meningitis occurred in spite of prophylactic sulfadiazine therapy which in the future treatment of such cases should be combined with penicillin. Autopsy findings indicated that the air, after entering the subarachnoid

space from the mastoid sinus or the middle ear, must have gained access to the ventricular system by normal channels.

The intraventricular pneumocephalus was disclosed in the course of routine roentgenograms of the skull, and the patient complained of no headaches or other symptoms at this time. Moreover, the cerebrospinal otorrhea was very slight and might easily have been overlooked. In view of the potential seriousness of the condition of pneumocephalus when it exists and the importance of instituting early and adequate prophylactic treatment for infection, roentgenographic examination should not be delayed unnecessarily in these cases.

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We are indebted to Dr. T. Weinberg, Chief of the Department of Radiology, Metropolitan Hospital

for his interest and help in the roentgenological studies of the cases illustrated in Figures 1 and 3.

REFERENCES

1. ADSON, A. W. Results following surgical repair of craniosinus fistula for cerebrospinal rhinorrhea; abstract of a published paper with comment on subsequent experience. *Proc. Staff Meet., Mayo Clin.*, 1942, 17, 281-286.
2. BARDEN, R. P. Traumatic pneumocranium. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 43, 514-516.
3. CAIRNS, H. Injuries of the frontal and ethmoidal sinuses with special reference to cerebrospinal rhinorrhoea and aroceles. *J. Laryng. & Otol.*, 1937, 52, 589-623.
4. CUSHING, H. Experiences with orbito-ethmoidal osteomata having intracranial complications. *Surg., Gynec. & Obst.*, 1927, 44, 721-742.
5. DANDY, W. E. Pneumocephalus (intracranial pneumatocele or arocele). *Arch. Surg.*, 1926, 12, 949-982.
6. KAPLAN, A. Traumatic pneumocephalus with spontaneous ventriculograms. *J. Neurosurg.*, 1944, 1, 166-170.
7. WORMS, G., DIDIÉE, L., and GRUMBACH, L. Pneumatocèles intracraniennes. *Ann. d'otolaryng.*, May, 1932, pp. 481-533.



CONGENITAL TALONAVICULAR SYNOSTOSIS ASSOCIATED WITH HEREDITARY MULTIPLE ANKYLOSING ARTHROPATHIES*

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IN 1879 Anderson¹ reported the first case of bilateral congenital talonavicular synostosis. In 1943 O'Donoghue and Sell² reported the second case, illustrated with roentgenograms and also mentioned five unilateral talonavicular fusions previously reported in the literature. Boyd² reported 4 cases in 1944. One was a girl, ten years of age, and the other 3 cases were in one family—grandmother, father, and a son of ten. All these cases were bilateral synostosis of the talus and navicular bones.

CASE REPORT

The patient was a soldier, aged twenty-three, two and a half years in the Army, one of eleven children—eight boys and three girls. He complained of pain and discomfort in both feet, insidious in onset. He has no swelling or visible deformity. Eversion and inversion of the feet are limited. The roentgenological examination of both feet revealed normal calcaneus. The tali are broader than normal and articulate with all three cuneiform bones and the calcaneus and the cuboid. The third cuneiform is in synostosis with the third metatarsal. The left foot reveals a very large os tibiale externum which is protruding medially into the soft tissues, corresponding to the site of pain. The right foot shows, at the same region, bulging indicating a fusion of the os tibiale externum with medial distal portion of the combined bones. The right calcaneocuboid articulation shows slight lipping and spur formation, due to the presence of an osteoarthritis, which might have been caused by the absence of the talonavicular articulation increasing the strain on the right calcaneocuboid joint. Each hand presents synostosis between the first and second phalanges of the fourth and fifth fingers and between the navicular and greater multi-



FIG. 1. Anteroposterior composite view of the right foot shows the fusion of the talus and os naviculare pedis. There is an osteoarthritis at the calcaneocuboid articulation.

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FIG. 2. Anteroposterior composite view of the left foot shows the fusion of the talus and os naviculare pedis and the presence of os tibiale externum, bulging medially into the soft tissues, causing pain.

angular of both wrists. The patient states that his father has the same deformity of the hands.

The structures³ of the peripheral joints are derived from the mesoderm. As early as the third week of intrauterine life, the future bones and joints can be distinguished as scleroblastema, extending from the vertebral column as axial rods in the limb buds. During the fifth and sixth weeks, because of condensations of cells and the lack of cell multiplication between these portions, the cores develop the appearance of chains of mesenchymal links. The condensed cellular structures are the progenitors of the bones and the loose intersegmental tissues develop into the joints.

The lack of development of mesenchymal cords, which are the progenitors of these bones, will result in the absence of the cuneiforms, second metatarsal, phalanges and fibula. The result is deformity, abnormal weight-bearing and static osteoarthropathy. The condensation of mesenchymal cells, without segmentation, results in absence of joint formation, which is de-

FIG. 3 (below). Oblique view of left foot showing the synostosis between the third cuneiform and the third metatarsal bone.



scribed as synostosis. The three phalanges of a finger may be fused as one.

Variations of the tarsus are ununited centers of ossification producing (1) vesalium, (2) trigonum, (3) peroneum, (4) epinavicular, (5) accessory talus, (6) os sustentaculum and (7) os tibiale externum.

the tarsal bones.⁴ This bone is the last one to ossify and it is considered the step-child among the bones of the foot. Due to the synostosis, the limited metatarsal blood supply is diverted to the os tibiale externum, causing its giant size and consequently the discomfort.

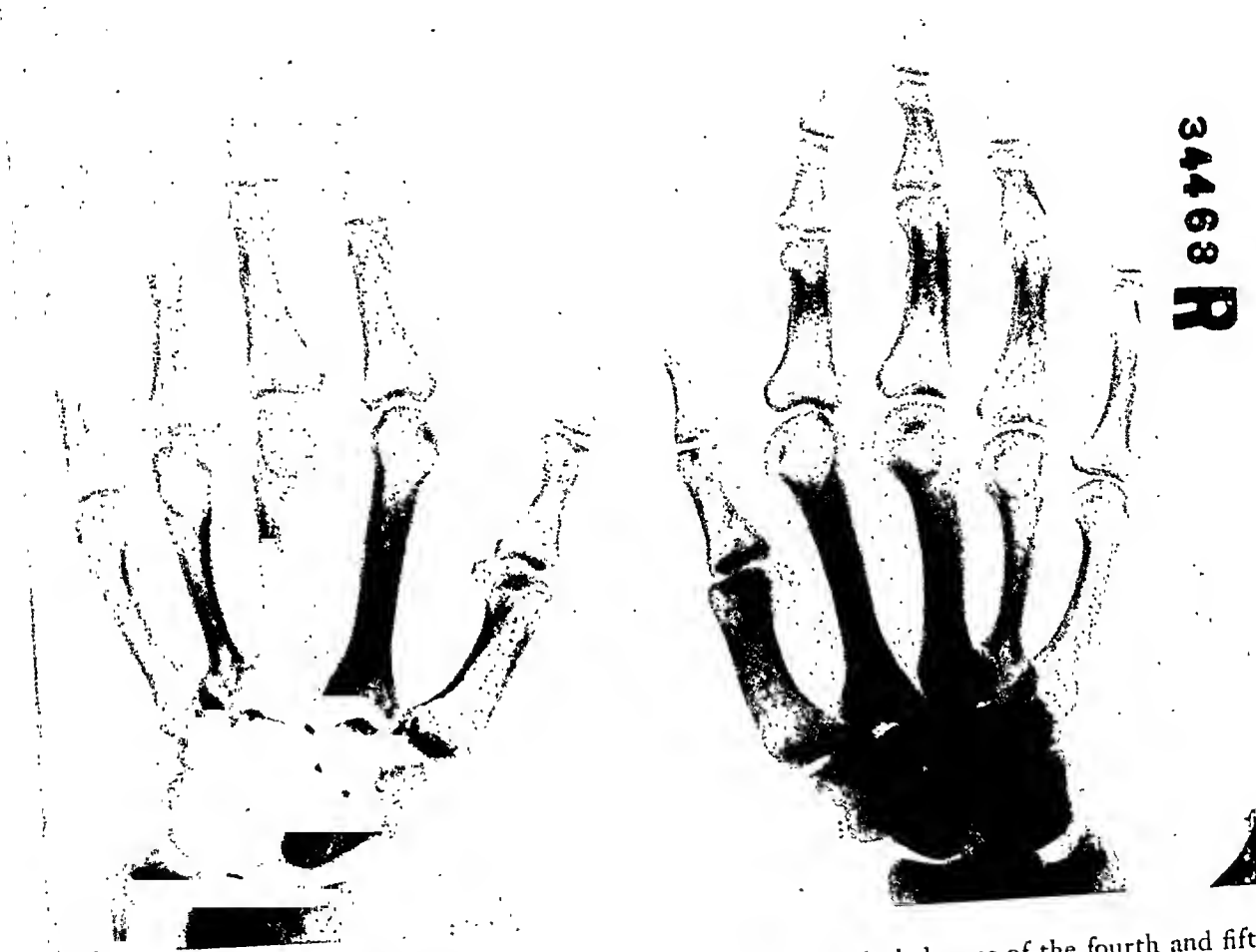


FIG. 4. Both hands present synostosis between the first and second phalanges of the fourth and fifth fingers and between the navicular and greater multangular.

They vary in number, in appearance, and in size. These accessory bones develop in childhood and later some of them show tendency of unification with the respective tarsal bones.

In this case, the os tibiale externum, which can be found in 10 per cent of the people, developed in one foot only and reached a giant size which obviously is the reason of his discomfort. The blood supply to the navicular bone is the poorest of all

SUMMARY

A case of bilateral congenital synostosis of the talus and navicular, with hereditary multiple ankylosing athropathy of the hands and wrists, is presented and illustrated by composite roentgenograms. A short embryological aspect of joint development is outlined.

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REFERENCES

1. ANDERSON, R. J. Presence of an astragalo-scaphoid bone in man. *J. Anat. & Physiol.*, 1879, 19, 452.
2. BOYD, H. B. Congenital talonavicular synostosis. *J. Bone & Joint Surg.*, 1944, 26, 682-686.
3. DE LORIMIER, A. A. The Arthropathies. Year Book Publishers, Chicago, 1943, pp. 34-44.
4. KÖHLER, ALBAN. Röntgenology. William Wood and Company, New York, 1928, pp. 120-122.
5. O'DONOGHUE, D. H., and SELL, L. S. Congenital talonavicular synostosis. *J. Bone & Joint Surg.*, 1943, 25, 925-927.



THE PATHOGENESIS OF CHARCOT'S JOINT

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IN 1868, Jean Martin Charcot,⁴ lecturing at La Salpêtrière on the joint conditions which appeared to accompany lesions of the central nervous system, drew attention to one he called "the ataxic form"—not previously described with any clarity—and in which the affected joint first gave evidence of an acute and unheralded effusion which left in its wake varying degrees of swelling and instability.

Charcot's enumeration of the findings and his careful analysis of the predisposing causes were the first to be presented with sufficient assurance to delineate as a clinical entity the neuropathic joint—the classical "Charcot joint" of *tabes dorsalis*—the one which, before the advent of roentgenograms became familiar to each generation of medical students as that in which there was the feeling of a "bag of bones."

Since Charcot's pronouncements met with almost instant disagreement, particularly from the famous German surgeon Volkmann, it may be of interest to review the text of them:

... Without any appreciable external cause we may see, between one day and the next, the development of a general and often enormous tumefaction of a member, most commonly without any pain whatever, or any febrile reaction. At the end of a few days the general tumefaction disappears, but a more or less considerable swelling of the joint remains, owing to the formation of a hydarthus; and sometimes to the accumulation of liquid in the periarticular serous bursae also. On puncture being made, a transparant lemon-colored liquid has been frequently drawn from the joint.

One or two weeks after the invasion, sometimes much sooner, the existence of more or less marked cracking sounds may be noted, betraying the alteration of the articular surfaces which, at this period, is already profound. The hydarthus becomes quickly resolved, leaving after it an extreme mobility in the joint. Hence

consecutive luxations are frequently found, their production being largely aided by the wearing away of the heads of the bones which has taken place. I have several times observed a rapid wasting of the muscular masses of the members affected by the articular disorder. . . . Besides the wearing down of the articular surfaces . . . you may notice the presence of foreign bodies, of bony stalactites, and, in a word, of all the customary accompaniments of arthritis deformans. The latter alterations were absolutely wanting in the first case (post-hemiplegic). On this account I am led to believe that they are nowise necessary and that they are produced in an accidental manner, and to all appearances chiefly by the more or less energetic movements to which the patient sometimes continues to subject the affected members. . . .

Now, as to Charcot's views on the pathogenesis of this sort of joint, and referring again to his original article:

The arthropathy of the ataxias . . . seems always later in time of appearance than the sclerotic changes in the spinal cord. I am even inclined to believe that they are subordinate to them, as it were It would be impossible to invoke, for the sake of proving a certain doctrine, a participation of the roots and of the lumbar spinal ganglions.

The "certain doctrine" to which he referred was that of Volkmann: the eminent German surgeon had almost immediately disagreed violently with Charcot's postulated rôle of the spinal cord itself in the production of joint changes which must have been, if one had followed Charcot unquestioningly, of a "trophic" nature.

Volkmann took the position that the spectacular joint changes were mechanical in origin—mechanical in the sense that they originated in a multiplicity of subclinical traumata which went unperceived because of the insensitivity of the affected joints.

Charcot treated Volkmann's contentions with a smile, and never devoted long to dismissing them. Volkmann, nevertheless, had a following; and when Virchow entered the controversy, throwing his influence entirely on Volkmann's side, their mechanical theory began to be known as the "German theory," while Charcot's concept of a trophic joint became known as the "French theory."

ETIOLOGIC CONSIDERATIONS

Perhaps the greater number of roentgenologic textbooks, in their introductory remarks on the neuropathic joint, refer to it as one observed in tabes, and sometimes in syringomyelia. Rather seldom are other causes touched upon, and the fact that Charcot himself described injury to the spinal cord as an etiologic factor elicits only an occasional comment.

While it is doubtless true that tabes and syringomyelia should receive first consideration in dealing with the etiologic factors, one must also recognize a large number of other conditions in which a typical neuropathic joint may be evolved: trauma to the spinal cord, trauma to posterior roots, cord tumors, congenital malformations (as spina bifida), spinal caries from tuberculosis, malignant tumor or other destructive process, acute myelitis, poliomyelitis, leprosy, toxic neuritis, and hemiplegic states.

Steindler⁴¹ calls attention to the fact that J. K. Mitchell in 1831 pointed out the connection between cord lesions and certain joint diseases; tabes was added by Charcot in 1868, myelitis by Weir Mitchell in 1875, anterior poliomyelitis by Laborde in 1873 and syringomyelia by Sokoloff in 1892, the latter reporting 20 cases from the literature and adding 3 of his own, the oldest case being that of Blasius in 1848.

Israel,¹⁹ reporting a case of neuropathic joint following a shrapnel wound of the spine, cited earlier similar cases from the literature: Riedel in 1883 had described a neuropathy involving a knee, associated with a hemiparalysis, and resulting from a knife wound of the back; Chipault had de-

scribed a case due to hematomyelia. Duncan¹¹ described an interesting case in which a lumberman forty-two years of age suffered an injury to the posterior spinal roots as a result of a blow from a falling log. The anterior motor roots were unaffected and the patient was able to use his arm. His right arm was swollen from shoulder to wrist; the shoulder joint space showed tremendous widening, the radius and ulna were hypertrophic and the carpus was disorganized. There was definite anesthesia throughout the length of the extremity.

On September 29, 1941, there was admitted to the West Suburban Hospital N. A., male, aged twenty-nine. He was brought in for a preliminary roentgenogram of the abdomen; since he presented symptoms of urinary sepsis, the film was ordered in a search for calculus.

The outstanding findings in the roentgenogram were with reference to the right hip, and, to a lesser extent to the spine. The history given by the patient was that fifteen years ago he had been thrown from an automobile, fracturing his spine at the level of the first lumbar vertebra; and that since that time, as the patient stated, "he had been paralyzed from the waist down."

Examination revealed loss of motor and sensory function in both lower extremities; there was saddle anesthesia, and further history revealed evidence of atony of bladder and rectum. The right hip was large and irregular in contour, with a tremendous bony overgrowth involving most of the articular structures.

Further roentgenograms were made for bone detail; they are shown in Figures 1 and 2. When one surveys the enormous and purposeless bone production involving all the structures of the right hip joint, the huge and hypertrophic shelf of new bone which has been thrown out from the acetabulum, the grotesque distortion of the trochanters, and the osteosclerosis which invades the innominate bone well up into the ilium, this articular monstrosity seems to defy classification into any other group than that of the joint neuropathies.

PROBLEMS IN PATHOGENESIS

Most textbooks, not only of roentgenology but of orthopedics and neurology,

briefly denominate all the neuropathic arthropathies as "trophic disturbances"—ascribing to them a common origin with the familiar perforating ulcers so often seen on the feet of tabetics.

This was the explanation which suggested itself to Charcot, and the one to which he clung, despite the vigorous objections of Volkmann and the scholarly dissensions of Virchow. The utter disorganization which these joints undergo, the



FIG. 1. Hip of patient suffering from biplegia of fifteen years' duration, the result of lumbar spine fracture. The left hip is virtually unchanged save for a few osteophytes along the superior border of the inferior ramus of the left pubic bone. The right hip shows changes characteristic of a neuropathic joint; there is no disarticulation, since there has been no weight bearing. Repeated turning of the patient on his right side for nursing care is considered the "traumatic" factor (Volkmann) which has produced the grotesque peri-articular changes. The spine shows a suggestively increased density.

lavish and purposeless production of new bone which appears about the articular areas, the great amount of osseous debris which accumulates all about the articulation certainly suggest, with the utmost logic, that here one is viewing such an alteration of nature's ordinary processes as could only take place in the presence of a most profound disturbance of regional nutrition.

As Duncan¹¹ puts it: "There is here an analogy to an insensitive tooth. It is essen-

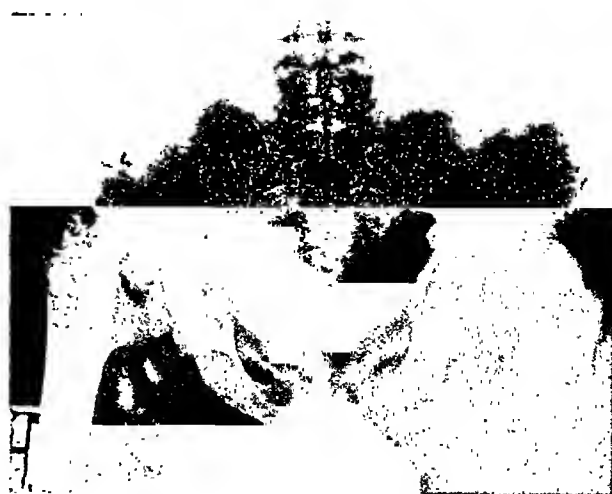


FIG. 2. Both of these hips (tabetic in origin) show a similar tendency to lavish production of new bone, though here the etiologic factor is quite different from the one operating in the case shown in Figure 1. Both Figures 1 and 2 illustrate what is usually referred to as the hypertrophic form of the arthropathy. It is to this sort of new bone production that Israel gave the name "kallus luxurians." Here, in contrast to Figure 1, there is disarticulation, the result of weight bearing.

tial that every organ receive not only an adequate supply of blood, but also maintain constant communication with the central nervous system. This it does through efferent and afferent nerves. The simplest reflex might be thought of as involving the



FIG. 3. Here is well illustrated the "atrophic" form of tabetic arthropathy. The femoral heads have disappeared on both sides, producing the "drumstick" femur of the French writers; a "wandering" acetabulum is evident bilaterally. Along the inner margin of the upper third of the left femur is exemplified the "myositis ossificans neurotica" of Israel.



FIG. 4. A neuropathic arthropathy of the elbow—the rareness of which, in tabes, has been emphasized by Warfield. The external condyle, rarefied and osteoporotic, has been fractured; the olecranon fossa and the internal condyle show sclerotic condensation and early osteophyte production, as does the upper end of the ulna, adding a bit of consistent evidence in support of the “traumatic” theory. Charcot elbows are much more common, relatively, in syringomyelia than in tabes.

sensory end organ, its fibers and cells in the spinal ganglion with a central branch arborizing around an anterior horn cell from which arises the motor nerve conveying an efferent impulse to distant muscle. However, the average reflex is much more complicated, one relay after another of nerve cells and fibers being employed, some peripheral, some spinal and some cerebral.” Duncan goes on to point out a similarity between a devitalized tooth and a joint which has been robbed of its nerve supply,

or of a portion of its nerve supply, stating that the changes seen in the surrounding areas in either case may be atrophic or hypertrophic in character; the result, he concludes, of a severance of the nerve supply to a part, from its central connections.

The question has repeatedly arisen as to just what nerves may be “trophic” nerves; where they run, what their relationship to the sympathetic system may be, whether or not they have separate and distinct centers in the spinal cord. Lafora²⁴ does not hesitate to commit himself rather definitely on the question of trophic centers: “The trophic medullary centers are situated near the sympathetic centers in the lateral horns in the dorsal cord and in the gelatinous substance of the lumbar cord.” Few others, however, share Lafora’s confidence, the



FIG. 5. Anteroposterior view of an arthropathy of the knee developing in a tabetic; note the exuberant and purposeless production of new bone, the origin of which was so much clarified by Steindler’s painstaking researches.

statement being much more frequently made that we have no definite knowledge of the existence either of trophic centers or of trophic nerves, and Eloesser¹³ appearing to substantiate such a statement with some very convincing experimental evidence.

Marinescu²⁹ believes that the sympathetics, per se, might be operative in the production of changes referred to as "trophic;" he points out that reactions to histamine and to adrenalin carry a certain weight of evidence in that they are sharper on the side of the neuropathy; concluding from this that vasomotor phenomena play



FIG. 6. Lateral view of the same knee shown in Figure 5. Note the "stalactite" of Charcot's original description, at the upper end of the tibia. Enormous production of extra-articular osteophytes. Similar osteitic excrescences, to some extent fractured, have appeared at the upper and lower ends of the patella; for this sort of ossification, Potts uses the term "parosteal new bone."



FIG. 7. A Charcot wrist (etiology, tabes). Degenerative changes in the carpus, dislocation at radio-carpal joint. Early new bone production all about the articulation; increased density in the lower end of the radius, ossifying periostitis, increased soft tissue density. History of intermittent hydrarthrosis.

a part, not only in the development of articular changes, but in the enormous bony overgrowth involving the periarticular soft parts.

Hildebrand¹⁸ advances a similar argument in discussing a neuropathic hip joint. Trophic changes, he asserts, are observed with equal frequency in central and peripheral lesions; the "neural nutrition" of a part must not be interfered with; it may involve bone, muscle or skin.

On this question Nielsen³⁰ says:

The question of trophic disturbances has never been settled. For many years it has been recognized that the life of an axon depends on its continuity with the cell body, and that in lesions of the lower motor neuron atrophy oc-

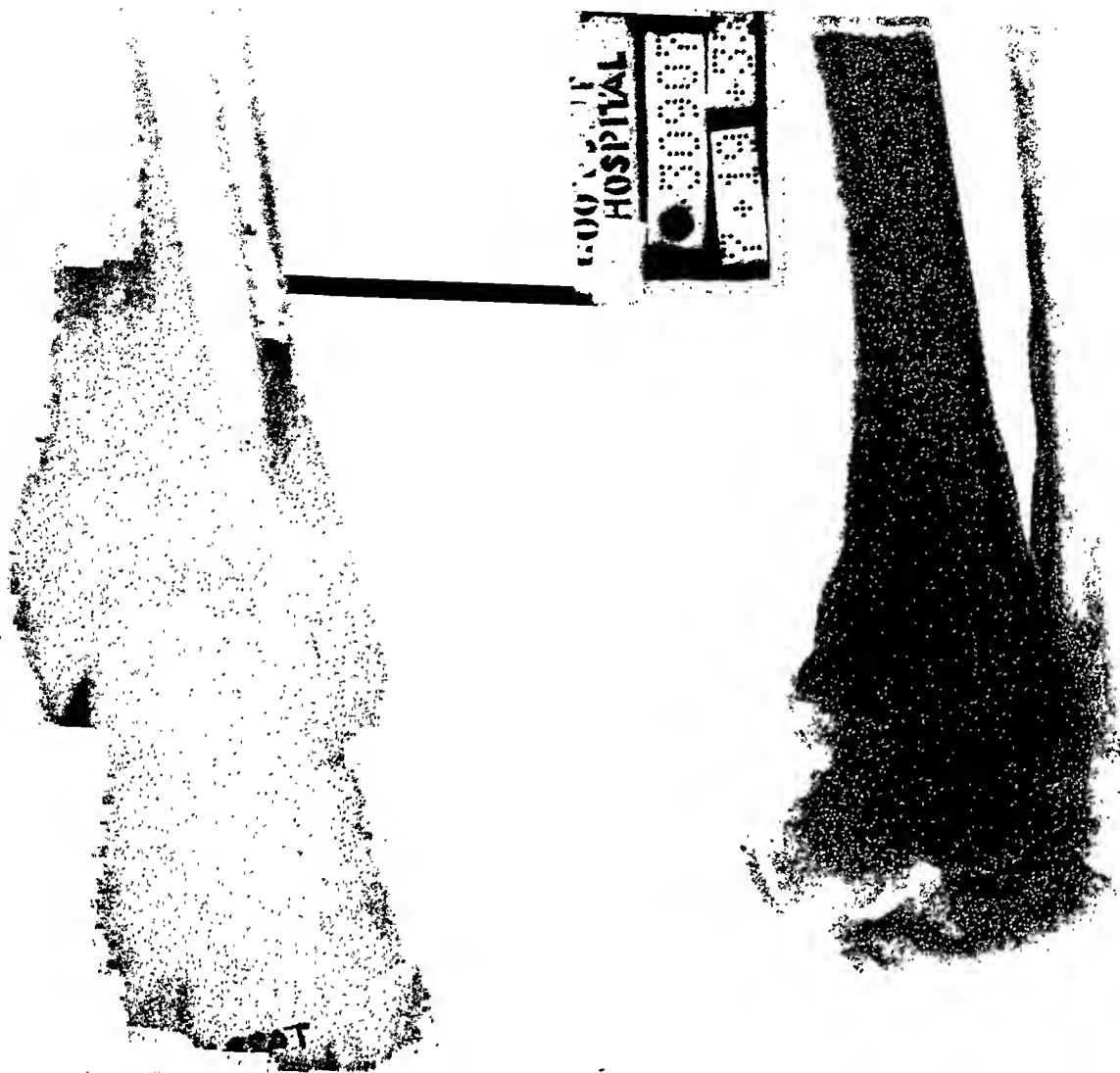


FIG. 8. A Charcot ankle (tabes). Above the destructive changes which may be seen at the lower tibial articular surface is dense sclerosis, and excessive new bone production, especially evident in the lateral view. The chief involvement is, of course, at the tibiotalar joint; one can, however, predict that the subastragaloid joint may soon show an increase of changes already evident.

curs not only in the muscles but in the deeper structures as illustrated by the cessation of growth or actual atrophy of bone in acute anterior poliomyelitis. This, however, is not the entire answer. It has also been known since the demonstration of von Monakow (thirty years ago) that lesions of the parietal lobe of the cerebrum cause early atrophy of the opposite side of the body. Severe trophic disturbances are the rule in complete transections of the cord.

The same author goes on to cite evidence that trophic disturbances often may not occur unless the vegetative nervous system is diseased or injured. The trophic lesions of tabes and syringomyelia, especially the perforating ulcers, the ureteral and vesical

disturbances of tabes, progressive facial hemiatrophy, scleroderma, the trophic lesions of polyneuritis, especially arsenical, all occur in diseases in which the vegetative fibers are affected. In acute anterior poliomyelitis the lateral horns of the spinal cord are affected almost as severely as the anterior horns, and in the cases of severe trophic disturbances postmortem examination shows a severe involvement of the lateral horns of the affected areas.

In section of the afferent root or ganglion of the trigeminal nerve, Nielsen states further, trophic disturbances of the eye are a source of great clinical trouble, but if the section is made in the medulla (tractotomy) behind the point at which the sympathetic

fibers join the fifth nerve, trophic lesions do not occur. It is true, he continues, that section of the sympathetic trunk in man is not followed by trophic disturbances; it seems that connection with the vegetative centers of the spinal axis is the essential element which prevents the trophic lesions, dissociation from the periphery the essential element which causes them. Nielsen quotes Archambault and Fromm to the effect that while the vasomotor fibers are not trophic fibers in themselves, they may very possibly run with such trophic fibers.

In dealing with the various lesions of syringomyelia which are grouped as "trophic," Grinker¹⁶ calls attention to the hardening and thickening of the skin of the affected parts, the coarseness and arrest of

growth in nails, the formation of indolent ulcers on the fingers, usually after an unperceived burn. Cigarette smokers frequently char and burn themselves, not feeling the heat from the cigarette in their fingers. Occasionally, spontaneous amputation of the distal portion of a finger occurs, due to the profound trophic changes. These, he points out, seem to be referable to the absence of normal pain and temperature sensation, permitting the injury to occur in the presence of a damaged vasomotor system which delays healing. (Is there not, here, a restatement of the essential portion of Volkmann's original contention?) And further, in the type of syringomyelia known as Morvan's disease—"The anesthetic and analgesic extremity is prone to develop

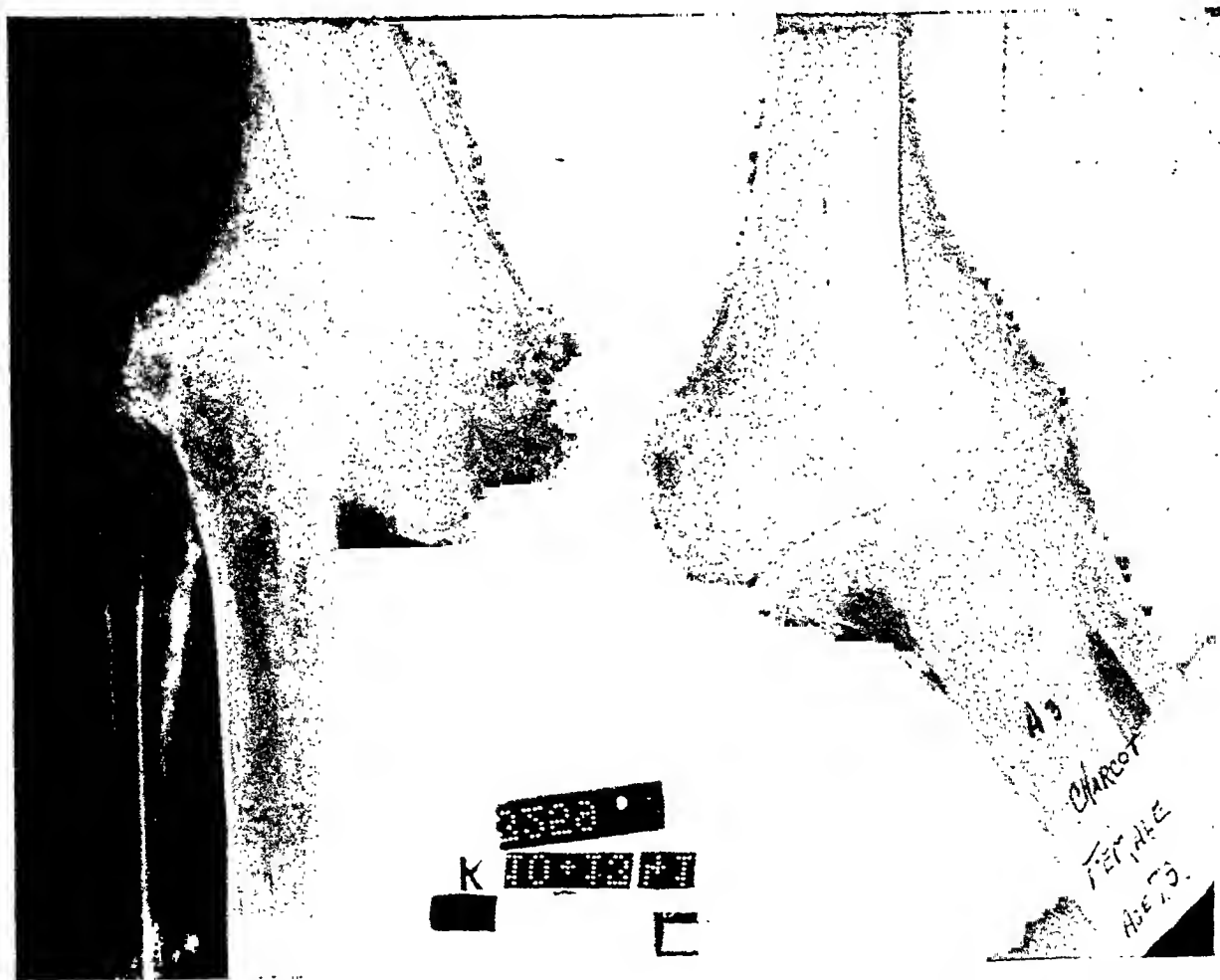


FIG. 9. Here the new bone production in no way approaches that seen in Figure 6. There are numerous intra-articular osteophytes, total disorganization of one articulation, partial disorganization of the other.

painless felons or whitlows which almost never heal, and completely destroy the phalanges involved. The vasomotor changes in Morvan's disease, and the gangrene, show a great resemblance to Raynaud's disease and it is interesting to note that one theory ascribes this latter disease to a lesion of the lateral gray columns."

Grinker makes clear that in his opinion the presence of special trophic fibers has by no means been proved. He quotes Tower, who showed experimentally that striped muscle is morphologically not at all affected by sympathectomy. What does occur is secondary change in the skin and subcutaneous tissues through alterations of the nerve supply to the blood vessels.

In 1917 Eloesser¹³ did a most important piece of work in the attempt to dispel some of the ambiguity which had continued to cling about the entire etiologic concept of the Charcot joint; his approach was most analytical, his efforts long continued and painstaking, and his work has been widely quoted.

In the publication of this work, he began with the following declaration:

We are no further in our knowledge of the joint lesions [of tabes] than we were twenty-five years ago. The best expositions of the subject date back to that time; more recent ones have added nothing new and have often left out of consideration facts of importance.

Do the nerves exert some mysterious "trophic" influence on the bone or will an alteration of the normal warning sense of pain suffice to explain the occurrence of osseous affections? Barth asked how we could hope to explain a neuropathic deforming arthritis when we did not even know the nature of an ordinary one.

Eloesser then cut a series of posterior roots, in cats, so as to ablate the sensory supply to a particular extremity, enough of them to make a total analgesia, anesthesia and ataxy. In this series, some of the cats developed Charcot's joints.

He produced joint changes in another series of animals, and, after waiting some time, cut the posterior roots; in the next

series he reversed the process, cutting the roots first, waiting, and then inducing a deforming arthritis. The cutting of the posterior roots appeared to have no appreciable effect on the amount of existent deformity in the cats with arthritis.

He then resected posterior roots in three cats, opened the joints and seared a spot on the femoral condyles with a thermocautery. Within three weeks, every cat thus treated developed a Charcot joint, with hydrops, deformity, and grating of joint surfaces. He goes on to say:

This was, then, not a slow aggravation of a pre-existing deforming arthritis; it was the sudden response of an anesthetic joint to the acute trauma of operation, a rapid reaction to bone injury by the production of the typical Charcot joint.

Attention is called to the fact that most of the Charcot joints are seen in early tabes—in patients still ambulatory and capable of inflicting the requisite trauma on a joint—in patients still ambulatory and capable of inflicting the requisite trauma on a joint recently become insensitive.

Soto-Hall and Haldeman,¹⁹ Steindler,⁴¹ Potts,³² Barth,¹ and others, have given excellent descriptions of the pathologic changes which take place as a neuropathic joint develops. The primary pathologic process is a degeneration and partial disappearance of the joint cartilage, which is invaded by a fibrous connective tissue from the pannus on its surface. In certain areas the zone of preliminary calcification is exposed by the stripping away of cartilage.

Beneath this zone there may be a proliferation of cartilage which becomes converted into subchondral bone, thus accounting for the sclerotic, eburnated bone seen at the base of large defects in the articular cartilage. A generalized atrophy of the trabeculae of the cancellous bone is often seen. In one instance a perivascular infiltration of lymphocytes was observed, though in the capsule of the knee joint this is a rare finding.

When well established, the lesions are quite typical. Two types of osteophytes are



FIG. 10. Some evidence of an effusion still persisting in the knee which has partially retained its articulation; the other illustrates very well Kienböck's expression "arthrosis deformans hypertrophica simplex."

usually seen. The first is a loose, detached bone fragment which may seem to be the result of recent fracture. Some such fragments become attached to the bone and grow, in an amorphous, purposeless fashion. Some, especially in the spine, seem to serve a purpose in that they bridge an interspace and lend support where instability is becoming marked.

In the spine, these osteophytes begin at the articular margins and resemble greatly the hypertrophic form of arthritis, but are usually larger than those seen in the latter condition. Within an affected vertebral body the bone is usually denser as from a calcareous infiltration. The osteophytes themselves are usually of good osseous integrity.

Both atrophic and hypertrophic forms of neuropathic arthropathy may be met with: in the former, relaxation of ligaments and displacement of articulating surfaces prevail; in the latter, proliferative changes

attract attention. Intra-articular and extra-articular osteophytes, exostoses, ossification of muscles and ligaments; joint cartilage ossification and marginal lipping at contact points, to be followed later by defibrillation of superficial and eburnation of deep layers, and destruction and resorption of the joint bodies, both intra-articular and extra-articular.

In the hip a "wandering" acetabulum may be encountered, and the femoral head may be lost by attrition, with part of the neck, producing the "drumstick head" of the French authors. The acetabulum may be perforated, with so-called "central dislocation" of the head of the femur.

Microscopically, cartilage may be lost in places, covered by vascular and cellular connective tissue, a form of pannus, while in the depths there is an abnormal proliferation of cartilage cells with formation of new cartilage islands. The spongiosa is of irregular structure, the spaces between the



FIG. 11. A Charcot spine. Marked increase in sclerotic density noted in the involved vertebrae, deformity of vertebral bodies, decrease in joint space between the fourth and fifth lumbar vertebrae. On the right, such marginal lipping as to justify the French expressions "bec de perroquet" and "foyer."

lamellae are filled with cellular and vascular connective tissue and contain giant cells similar to those seen in giant cell tumors; but whether these are osteoblastic or come from the endothelium of the blood vessels or from fibroblasts is not determined.

In the cartilage, vacuoles are observed, but these are secondary regressive changes and precede the transformation of cartilage into connective tissue. Destruction of cartilage is accompanied by destruction of underlying spongiosa with the formation of large crevices and defects. Bone absorption is carried out by giant cells; never is necrosis found.

The destruction and absorption of cartilage occur from the pannus above and from the spongiosa below; in this way hollow spaces, called the Weichselbaum lacunae, are formed, and the cartilage becomes honeycombed.

The particularly characteristic point for the neuropathic arthropathies is that the endochondral ossification under the joint cartilage, which ordinarily becomes stationary with formation of a continuous limiting bone lamella, the so-called preliminary calcification zone is now becoming extensively revived. The first step of this revival is the proliferation of the joint cartilage. The second step is a forward pushing of the preliminary calcification zone, and the third step is a penetration of vascular marrow recesses into this zone and then into the now calcified cartilage.

The joint reacts on all occasions with the resumption of endochondral ossification. *The degree of this ossification is so great and so diverse, that, by dint of simultaneous absorption and proliferation an enormous incongruity of the joint surfaces may result.* (Steindler)

Relative to the case which I have described above, in which a neuropathic joint developed in a patient who for fifteen years had been bedfast, the question might be asked as to the source of "trauma," if trauma is to be accepted as the activating force in the production of the new bone seen about the acetabulum and trochanters; the answer is to be found in the fact that during most of this prolonged period of inactivation the patient had, as a matter of habit, been turned on his right side for nursing care. The continued pressure of the body weight may be seen to be quite adequate as a source of trauma in an insensitive joint, if one reflects that the "trauma" ordinarily suffered consists in no more than that received in ordinary locomotion—in the physiologic use of a joint.

CONCLUSIONS

1. There is no definite evidence of the existence of "trophic" nerves.
2. The changes observed in neuropathic arthropathy appear to be brought about by repeated subclinical traumata occurring in an insensitive joint.

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REFERENCES

1. BARTH. Histologische Knochenuntersuchung bei tabischer Arthropathie. *Arch. f. klin. Chir.*, 1903, 69, 174-180.
2. BASCH, G., and VIAL, G. Ostéo-arthropathie pseudo-tabétique des deux pieds, symptôme révélateur d'une syringomyélie lombo-sacrée. *Bull. et mém. Soc. méd. d. hôp. de Paris*, 1936, 52, 405-410.
3. BOYD, WILLIAM. The Pathology of Internal Diseases. Lea & Febiger, Philadelphia, 1940.
4. CHARCOT, J. M. Sur quelques arthropathies qui paraissent dépendre d'une lésion du cerveau ou de la moelle épinière. *Arch. d. physiol. norm. et path.*, 1868, 1, 161-178.
5. CHARPENTIER, A., and CASTIAUX, P. Dysarthrie paradoxale vraisemblablement postencéphalitique. *Rev. neurol.*, 1927, 1, 635-639.
6. CHITTY, H. Interesting case of Charcot's joint. *Brit. J. Surg.*, 1939, 27, 183-185.
7. CLERC, A., MACREZ, C., and SOULLARD, J. Ostéo-arthropathies digitales et vertébrales à type de rhumatisme déformant chez un tabétique. *Bull. et mém. Soc. méd. d. hôp. de Paris*, 1939, 55, 1036-1040.
8. CLEVELAND, M. Fusion of knee joint in Charcot's disease. *J. Bone & Joint Surg.*, 1935, 17, 1031-1034.
9. CONLEY, A. H., and MILLER, D. S. Atrophic Charcot's hips. *J. Bone & Joint Surg.*, 1940, 22, 638-644.
10. COTTON, F. J. Surgical aspects of Charcot joint and other syphilitic bone and joint lesions. *Ann. Surg.*, 1920, 72, 488-493.
11. DUNCAN, J. H. Neuropathic arthritis. *J. Am. M. Ass.*, 1922, 79, 1987-1989.
12. EIKENBARY, C. F. Second report on a hitherto undescribed dystrophy, probably of luetic origin, affecting, particularly, the joints of the lower extremity. *J. Bone & Joint Surg.*, 1927, 9, 387-403.
13. ELOESSER, L. On the nature of neuropathic affections of joints. *Ann. Surg.*, 1917, 66, 201-207.
14. GLYN-HUGHES, F., and WEBSTER, R. C. Three cases of joint disease beginning during active treatment of syphilis. *Brit. M. J.*, 1936, 2, 972.
15. GRANT, S. A. Charcot's disease of interphalangeal joints. *Brit. M. J.*, 1924, 1, 1002.
16. GRINKER, R. R. Neurology. Second edition. Charles C Thomas, Springfield, Ill., 1937.
17. HEYMAN, C. H. Charcot joint following trauma. *Ohio M. J.*, 1923, 19, 496-498.
18. HILDEBRAND, O. Über neuropathische Gelenkerkrankungen. *Arch. f. klin. Chir.*, 1921, 115, 443-492.
19. ISRAEL, A. Über Myositis ossificans neurotica nach Schussverletzung des Rückenmarkes. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1919-1921, 27, 365-374.
20. KATSUKI, S. Beitrag zur experimentellen neuropathischen Arthropathie und zugleich zu deren Pathogenese. *Ztschr. f. klin. Med.*, 1936, 130, 567-574.
21. KEY, J. A. Clinical observations on tabetic arthropathies (Charcot joints). *Am. J. Syph.*, 1932, 16, 429-446.
22. KIENBÖCK, R. Über die Entstehung der Arthropathien bei Tabes. *Wien. med. Wchnschr.*, 1926, 76, 1035-1037.
23. KONWALINKA, H. Ein Fall von infantiler Tabes dorsalis mit Spontanfrakturen. *Wien. klin. Wchnschr.*, 1935, 48, 1443-1446.
24. LAFORA, G. R. À propos des théories pathogéniques des arthropathies tabétiques. *Rev. neurol.*, 1929, 1, 32-34.
25. LEADER, S. A. Charcot's arthropathy of both ankles. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 43, 509-513.
26. LIBER, A. F. Nature of the Rosenthal fibers in cases of syringomyelia with intermedullary tumor. *Arch. Path.*, 1936, 21, 863-864.
27. MALIWA, E. Tropische Störung nach Verletzung peripherer Nerven mit besonderer Berücksichtigung der Knochenatrophie. *Med. Klin.*, 1917, 13, 733-736.
28. MANDEVILLE, F. B. Roentgen findings in Morvan's type of syringomyelia. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1938, 40, 230-239.
29. MARINESCU, G., and BRUCH, H. Zur Kenntnis der Gelenkstörungen bei Tabes. *Ztschr. f. klin. Med.*, 1937, 132, 178-182.
30. NIELSEN, J. M. A Textbook of Clinical Neurology. Paul B. Hoeber, Inc., New York, 1941.
31. PHILIPS, H. B., and ROSENBECK, C. Neuroarthropathies; consideration of the etiology and general characteristics. *J. Am. M. Ass.*, 1924, 82, 27-29.
32. POTTS, W. J. Pathology of Charcot joints. *Ann. Surg.*, 1927, 86, 596-606.
33. RAMOND, L. A propos d'une "jambe noire." *Presse méd.*, 1936, 44, 1175-1176.
34. RIDLON, J., and BERKHEISER, E. J. Neuropathic arthropathies—Charcot's spine. *J. Am. M. Ass.*, 1922, 79, 1467-1475.
35. ROGER, H., VIGNE, P., and RECORDIER, A. M. Le tabes polyarthropathique. *Presse méd.*, 1937, 45, 118-120.
36. ROTTER, J. Die Arthropathien bei Tabiden. *Arch. f. klin. Chir.*, 1887, 36, 1-71.
37. ROUSSY, G., HUGUENIN, R., and KYRIACO, N. Syndrome syringomyélique d'origine vraisemblablement traumatique, d'évolution lente, extériorisé surtout par des arthropathies. *Rev. neurol.*, 1929, 1, 98-102.
38. SHANDS, A. R., JR., and RANEY, R. B. Handbook of Orthopaedic Surgery. Second edition. C. V. Mosby, St. Louis, 1940.

39. SOTO-HALL, R., and HALDEMANN, K. O. Diagnosis of neuropathic joint disease (Charcot joint). *J. Am. M. Ass.*, 1940, *114*, 2076-2078.
40. STAMM, T. T. Aetiology and treatment of osteo-arthritis. *Lancet*, 1939, *2*, 754; 802.
41. STEINDLER, A. Tabetic arthropathies. *J. Am. M. Ass.*, 1931, *96*, 250-256.
42. THOMAS, A., and HUC, G. A propos de la nature des ostéo-arthropathies nerveuses. *Rev. neurol.*, 1938, *70*, 573-584.
43. WARFIELD, C. H. Charcot's disease of the elbow joint. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1933, *29*, 530-532.
44. WILE, U. J., and BUTLER, M. G. Critical survey of Charcot's arthropathy. *J. Am. M. Ass.*, 1930, *94*, 1053-1055.
45. WILSON, S. A. K. *Neurology*. Edited by A. N. Bruce. William Wood & Co., Baltimore, 1940.
46. Transactions of the Section on General Surgery of the College of Physicians of Philadelphia. Charcot's disease of the knee. *Ann. Surg.*, 1897, *25*, 489-490.



A NEW SERIES OF RADIOPAQUE COMPOUNDS*

I. CHEMICAL STRUCTURES, CHANNELS OF EXCRETION AND ROENTGENOGRAPHIC USES†

By BERNARD S. EPSTEIN, M.D.
(CLINICAL AND ROENTGENOLOGIC ASPECTS)

SAMUEL NATELSON, Ph.D.

and

BENJAMIN KRAMER, M.D.
(CHEMICAL ASPECTS)

THIS communication presents a hitherto unreported series of compounds which have the physiological properties of being excreted through the liver and biliary tract and the kidneys. By virtue of the iodine constituent of the various members of the series roentgenographic visualization of the gallbladder, the urinary bladder and to a slight degree the kidney pelvis and calices may be obtained in varying degrees of intensity. The entire series is nontoxic and is readily tolerated by the human organism without any unpleasant reactions.

The two compounds now used for oral cholecystography are tetraiodophenolphthalein³ and beta (4-hydroxy-3,5-diiodophenyl)-alpha-phenyl-propionic acid.^{4,5} Another compound, diiodo-atophan, was used for a short time but was discarded because of toxicity.⁶ Tetraiodophenolphthalein, commonly used as its sodium salt, is often accompanied by gastric irritability and has cathartic properties which may distress the patient, and unabsorbed particles may remain in the gastrointestinal tract resulting in disturbing roentgenographic shadows. However, it is an efficient compound and produces adequate gallbladder visualization. The propionic acid derivative, which is used as the free acid, is better tolerated and likewise is efficient for gallbladder roentgenography. However, untoward systemic reactions such as diarrhea, intestinal cramps and burning on urination have been encountered after oral

administration.⁷ Intravenously it is a convulsant drug and has resulted in death in doses varying from 100 to 200 milligrams per kilogram of body weight in cats.⁵

A review of the chemical structure of the reported oral cholecystographic compounds suggested to one of us (S. N.) that a series of compounds might be evolved which would combine adequate gallbladder visualization with minimal or no toxic side reactions. The optimum requirements for such compounds were considered to be the following:

1. The compounds should have a molecular structure which is borne to the liver. Such a group would be the phenolic group, which is known to be detoxified in the liver either as the sulfate ester or the glucuronide, and which is a product of normal body metabolism.

2. The molecule should contain a carboxy group so that the sodium salt may be formed to facilitate the solution of the compounds in bile.

3. The molecule should have an iodine content sufficient to render it radiopaque in the quantities present in the gallbladder.

4. The compound should be fat soluble so that it would pass through the liver and gallbladder rather than through the kidney as would occur with water soluble compounds. To achieve this fat solubility it was decided to use an iodinated aromatic nucleus with aliphatic side chains.

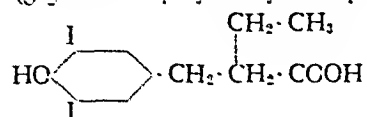
It was also decided that the number of

* From the Pediatric Research Laboratory (Dr. B. Kramer) and the Department of Radiology (Dr. M. G. Wasch), The Jewish Hospital of Brooklyn, Brooklyn, New York.

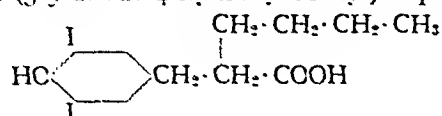
† Aided by a grant from National Synthetics, New York.

TABLE I—(continued)

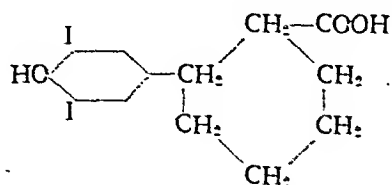
9. alpha-(3-5-diiodo-4-hydroxy-benzyl) butyric acid



10. alpha-(3-5-diiodo-4-hydroxy-benzyl) caproic acid



11. 3-5-diiodo-4-hydroxyphenylcyclo-hexanoic acid



12. 3-5-diiodo-4-hydroxyphenylcyclohexylacetic acid

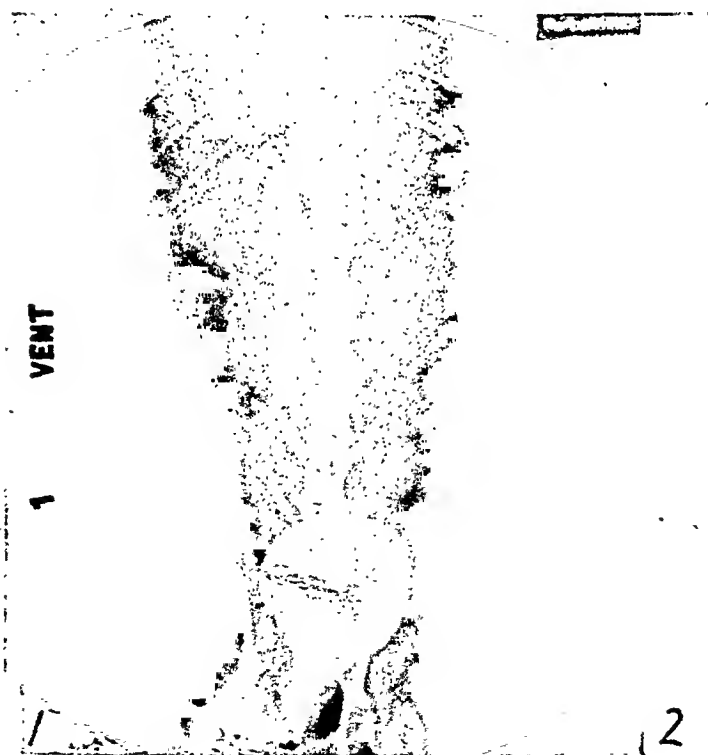
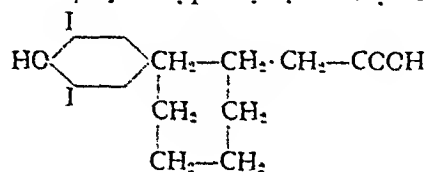


FIG. 1. Roentgenogram of the abdomen of a rabbit two hours after the intravenous injection of 500 milligrams of 3-5-diiodo-4-hydroxyphenylacetic acid. The urinary bladder is sharply visualized. The gallbladder is not visible. There were no untoward reactions.



FIG. 2. Roentgenogram of the abdomen of a dog weighing 3 kilograms six hours after the intravenous injection of 3 grams of 3-5-diiodo-4-hydroxyphenylacetic acid. Both the gallbladder and the urinary bladder are well visualized; there were no untoward reactions.

isolated 500 milligrams of this compound from 25 liters of normal human urine. Tyrosine is one of the essential amino acids present in all complete proteins.

In developing this series of compounds all the subsequent members were constructed as homologues of iodinated parahydroxyphenylacetic acid. A homologue is a compound which differs from the adjacent members of the series by a change in molecular weight of CH_2 . As a rule the progressive lengthening of an aliphatic chain increases its oil solubility and its chemical inertness, and decreases its water solubility.

A series of thirty-one such iodinated compounds was prepared, of which twelve were selected for further study.⁹ With the exception of parahydroxydiiodophenylpropionic acid, all these compounds have never been reported before. The twelve selected were chosen because of their ease

of preparation and low cost. As will be noted in Table I the first eight members are straight aliphatic chain compounds containing from two to eleven carbons. The remaining four compounds contain the carbons in branched and cyclic side chains. Absolute purity of the compounds is essential in avoiding any unpleasant systemic reactions.

We made a study of the available experimental animals for evaluating gallbladder opacifying compounds with interesting results. Chicks, rabbits, frogs and dogs were used. The first three were unsatisfactory inasmuch as their gallbladders did not visualize with any compounds including our own. Although results with dogs were rather difficult to evaluate, they were fairly satisfactory. We found that the short chain members of our series visualized dog gallbladders better than human gallbladders, while the longer chain members

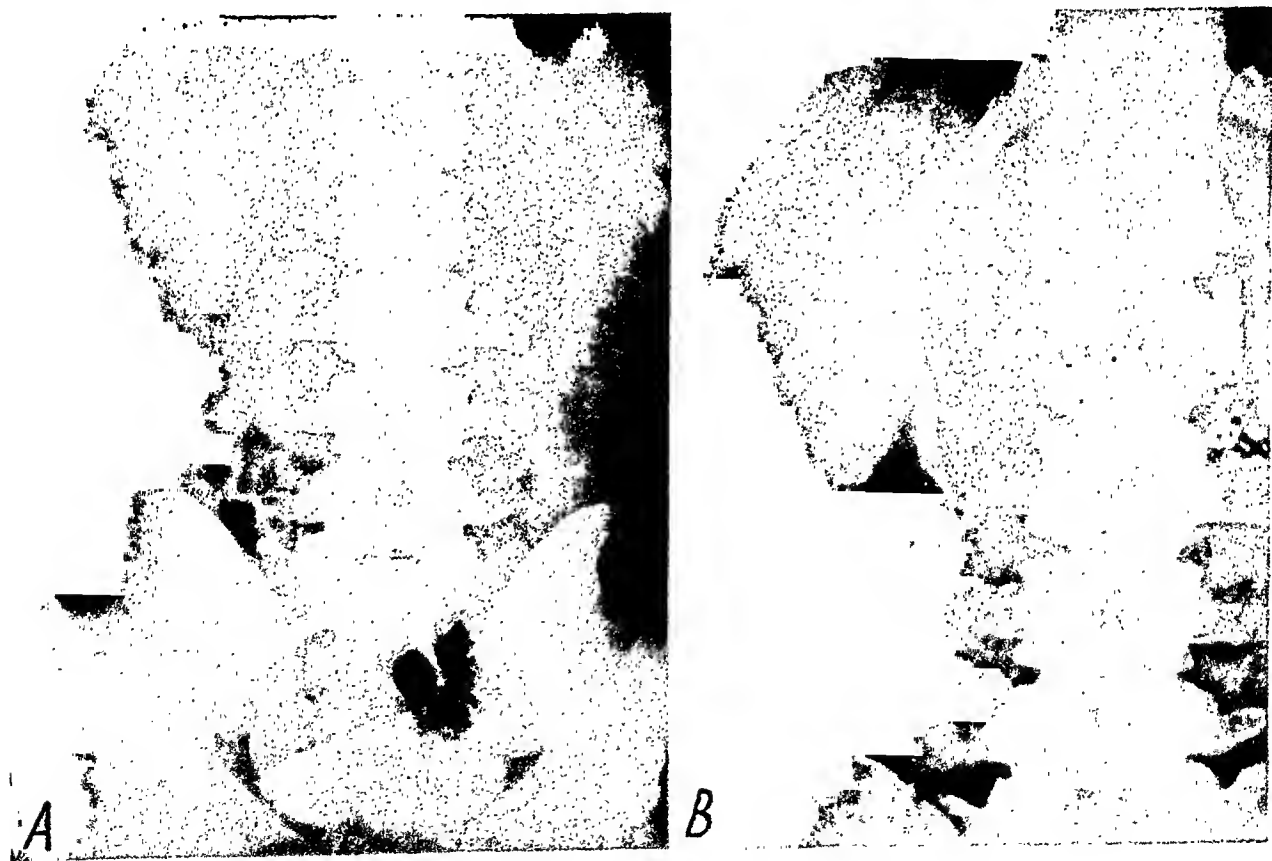


FIG. 3. *A*, roentgenogram of the abdomen of an adult male volunteer eight hours after the oral ingestion of 3 grams of 3-5-diiodo-4-hydroxyphenylacetic acid. Both the gallbladder and the urinary bladder are fairly well visualized, and the left renal pelvis is faintly outlined. There were no systemic reactions. *B*, roentgenogram of the right upper abdomen of the same patient taken ten minutes later. The right renal pelvis and upper ureter are well visualized. The calices are obscured by the opacified gallbladder.

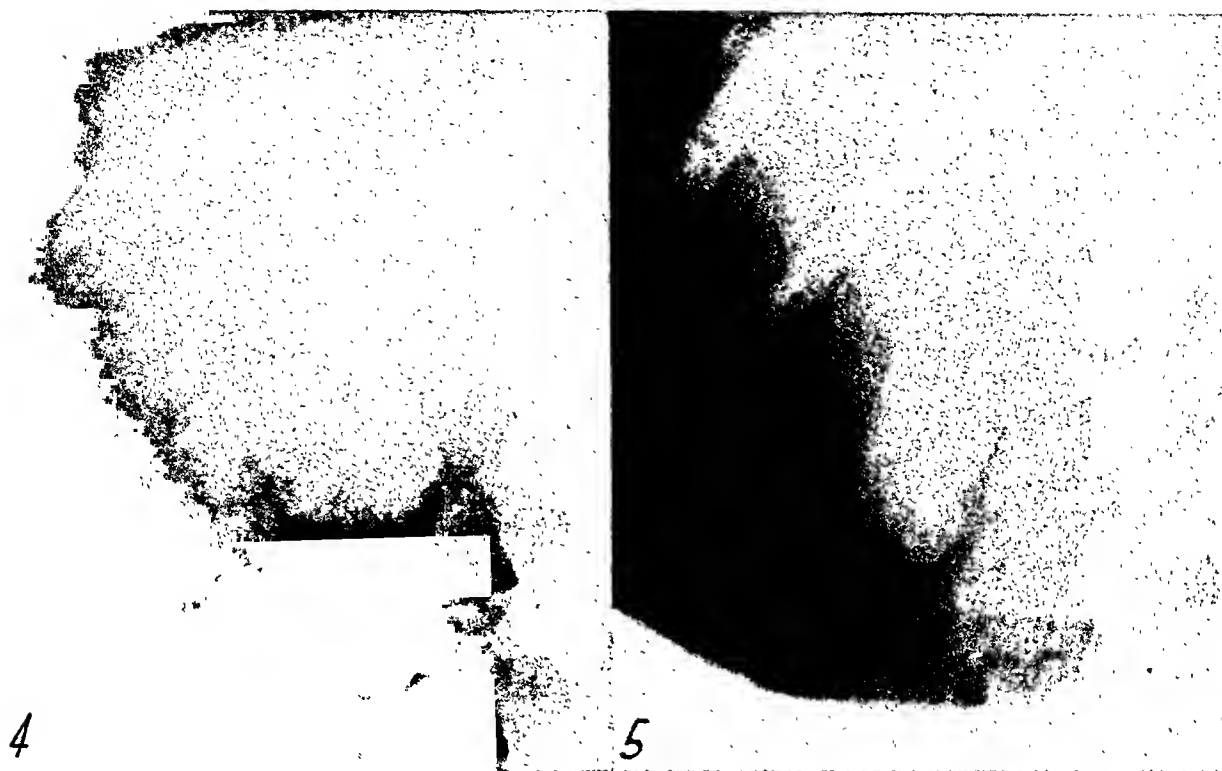


FIG. 4. Roentgenogram of the right upper abdomen of an adult male volunteer twelve hours after the oral ingestion of 3 grams of 3-5-diiodo-4-hydroxyphenylundecanoic acid. The gallbladder is fairly well visualized. Unabsorbed particles persist in the hepatic flexure. There were no systemic reactions.

FIG. 5. Roentgenogram of the right upper abdomen of an adult female volunteer twelve hours after the oral ingestion of 3 grams of 3-5-diiodo-4-hydroxyphenylbutyric acid. The gallbladder is fairly well visualized. There were no systemic reactions.

visualized human gallbladders more intensely than canine gallbladders. It is important in considering this experimental work on dogs to recall that the canine gallbladder lies high and close to the midline, and is often obscured by the spine. Oblique and lateral roentgenograms may be necessary to visualize this structure. Ultimately we tested the various compounds on dogs and rabbits for evaluating toxicity, and relied on human volunteers for evaluating the compounds for use in diagnostic procedures.

All the compounds in this series were found to be free from untoward physiological reactions in oral doses varying from 3 to 9 grams. All the compounds were given intravenously to rabbits in doses of 500 mg. per kilogram body weight without ill effect. Three grams of diiodoparahydroxyphenylacetic acid were given intravenously to an 8 pound dog without ill effect. A 2.5 kilogram cat was given

doses of 250 and 500 mg. per kilogram body weight of α -ethyl- β -3,5-diiodo-4-hydroxyphenylpropionic acid intravenously without untoward reaction. More than 50 volunteers have taken oral doses of from 3 to 9 grams of the latter compound with remarkably little reaction. An occasional individual noticed a fleeting sensation of irritation on starting the urinary stream. Gastric distress and loose stools were insignificant, and true diarrhea has not been encountered. We have found doses from 3 to 5 grams completely adequate for clinical purposes.

The short chain compounds pass rapidly through the kidneys but slowly through the gallbladder. Because of this, good cystograms may be obtained in from six to eight hours by the oral route. The visualization of the gallbladder with these compounds is only fair. Kidney visualizations have been unsatisfactory as a rule with the compounds tested.

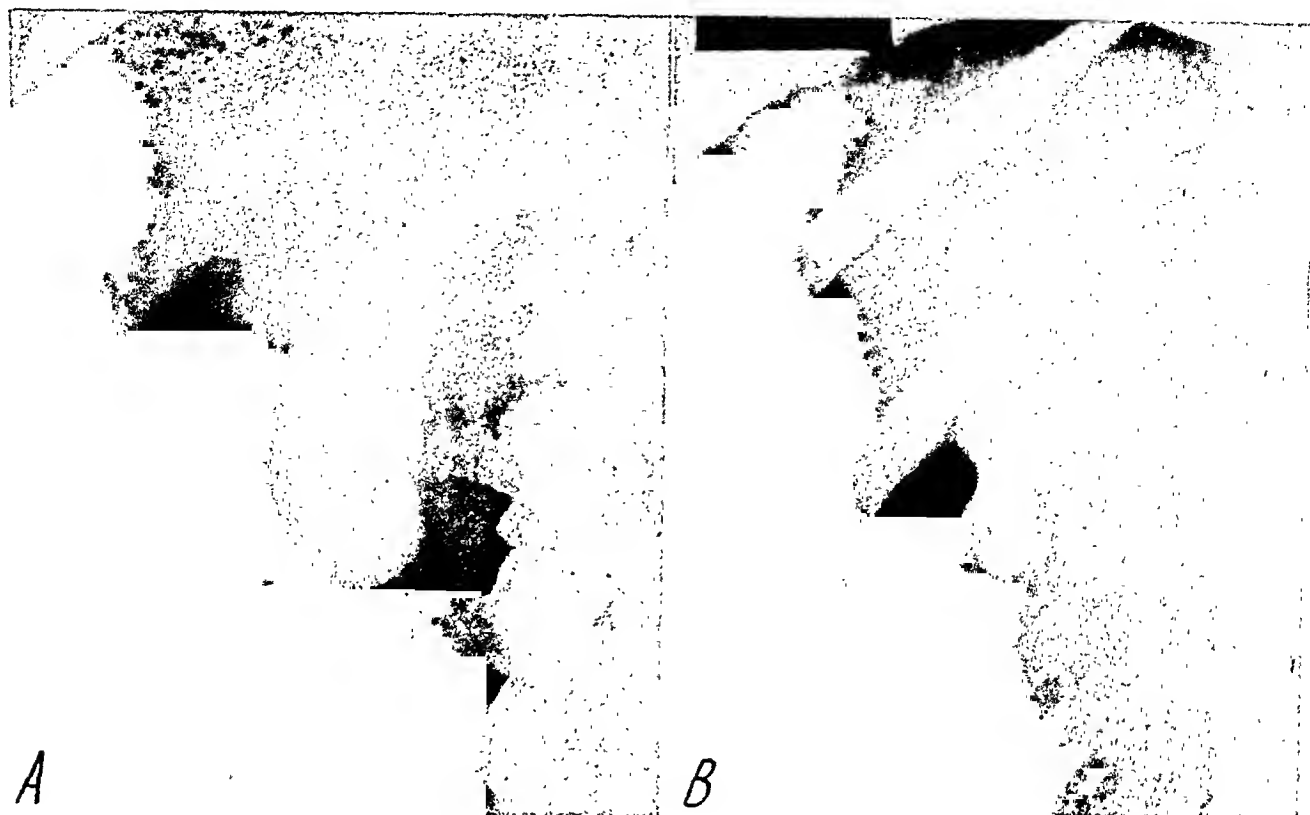


FIG. 6. *A*, roentgenogram of the right upper abdomen of an adult female volunteer twelve hours after the oral ingestion of 3 grams of alpha-ethyl beta (3-5-diiodo-4-hydroxyphenyl) propionic acid. The gallbladder is very well visualized. There were no systemic reactions. *B*, roentgenogram taken one hour after a prepared fatty meal (cholex). The gallbladder has contracted sharply.

The longer chain compounds, which are more oil soluble, are excreted principally from the liver into the gallbladder. Their



later passage through the kidneys is demonstrated by the fact that good cystograms may occasionally be obtained together with oral cholecystograms. Oral cholecystograms which compare favorably with those obtained with reported compounds have been obtained consistently. At the present time we have narrowed the best compounds in the series to those containing saturated nuclei of from five to eight carbon atoms. These are sufficiently heavy to be extracted by the biliary tract, visualize the gallbladder and leave no trace of the opaque substance in the gastrointestinal tract. The longer carbon chains beyond the eight carbon nucleus likewise are excreted primarily through the biliary tract but may remain in small granules in the intestinal tract, resulting in small but disturbing

FIG. 7. Roentgenogram of the right upper abdomen of an adult female volunteer twelve hours after the oral administration of 3 grams of alpha-ethyl beta (3-5-diiodo-4-hydroxyphenyl) propionic acid. The gallbladder was very well visualized and there were no systemic reactions.

opacities from the roentgenographic viewpoint.

At the present time we have selected two compounds for more intensive clinical investigation. These are numbers 9 and 10 in Table I, containing 57.0 per cent and 53.4 per cent iodine respectively. Thus far we have used these compounds in 50 volunteers in our laboratory and are satisfied that they are nontoxic and satisfactory for use in diagnostic procedures. Further investigation is in progress to test the various homologues in the series for their relative roentgenographic intensities in the study of the gallbladder and urinary tract.

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REFERENCES

1. BAUMANN. *Ber. d. deutsche chem. Gesellsch.*, 1882, 12, 280.
2. BEST, C. H., and TAYLOR, N. B. *The Physiological Basis of Medical Practice*. Second edition.
3. GRAHAM, E. A., and COLE, W. H. Roentgenologic examination of the gall bladder. *J. Am. M. Ass.*, 1924, 82, 613-714.
4. GRUNKE, W., and FINGER, H. Cholecystographie mit dem neuen peroralen Kontrastmittel Biliselectan. *Klin. Wchnschr.*, 1940, 19, 1187-1189.
5. MODELL, W. Pharmacology of β (3,5 di-iodo-4-hydroxyphenyl) α phenyl propionic acid. *J. Lab. & Clin. Med.*, 1942, 27, 1376-1384.
6. ORATOR, V., and WALCHSHOFER, E. Zwei Beiträge zur Cholecystographie: tierexperimenteller Vergleich der verschiedenen Gallenblasen-Kontrastmittel. *Deutsche Ztschr. f. Chir.*, 1927, 205, 86-91.
7. PAUL, L. W., and POHLE, E. A. Oral cholecystography; comparative study of single- and divided-dose method with contrast media in liquid and solid form. *Radiology*, 1944, 42, 226-232.
8. RATING, B. Ueber ein neues Kontrastmittel zur Röntgendarstellung der Gallenblase (Biliselectan). *Fortschr. a. d. Geb. d. Röntgensstrahlen*, 1941, 73, 99-110.
9. NATELSON, KRAMER, TEKEL. U. S. Patent No. 2,400,433 (May 14, 1946).



CAPSULES AND INSERTER FOR THE USE OF RADIUM CELLS IN THE TREATMENT OF CANCER OF THE UTERINE FUNDUS

By LLOYD A. CAMPBELL, M.D.
SAGINAW, MICHIGAN

THE use of a multiple capsule technique to increase the effectiveness of radium treatment in cancer of the fundus of the uterus is generally accepted by the profession. Although the number, size, shape and methods of application of the source may vary,^{1,2,3,4,5} they all are based upon the use of many small, relatively weak capsules which are packed into the uterine cavity until it is filled.

To this treatment the standard platinum cell with its small size and relatively weak

The capsule is held by a wire stem consisting of four strands of No. 30 stainless steel wire tightly twisted together and looped at the proximal end to fit over a small retaining post on the plunger. The wire as thus made is stiff enough to retain the capsule where it was originally placed and the protruding wires aid in a better drainage of the uterine cavity. Replacement of new wires can be easily accomplished without special tools or skill. A Deknatel letter bead is threaded on the wire for identification as the capsules are best removed from the uterus in the reverse order



FIG. 1. Inserter ready for use with a capsule in place and the wire loop over the retaining post.

radium content can readily be adapted. Each capsule contains four cells giving a total filter equivalent to 1 millimeter of platinum. The capsules have an over-all length of 19 mm. and a diameter of 6 mm. The eye end of the capsule and the receptacle of the inserter are accurately machined at corresponding angles to fit together similar to a ground joint. This gives a rigidity to the capsule as it is tightly held by the inserter, thus making an easier and a more exact placement within the uterus.

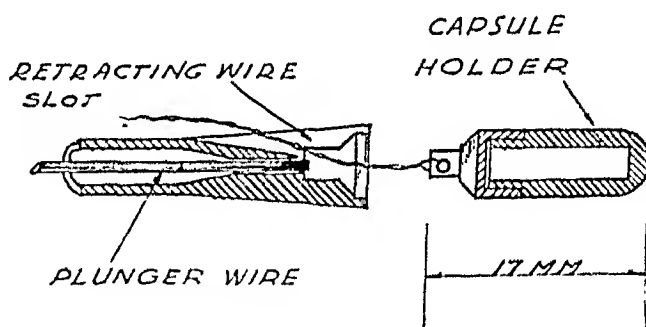


FIG. 2. Cross section drawing through the receptacle and capsule showing the corresponding surfaces which hold the capsule rigidly.

of their placement. With the cervix sufficiently dilated at the time of introduction, no difficulty has been experienced in their removal if this procedure is followed.

The inserter consists of the capsule receptacle as described, a hollow curved shank long enough for usual uterine work, and a handle of finger rests and plunger to which is attached a retaining post for the wire loop. The plunger extends the entire length of the instrument and is retracted constantly under tension supplied by a coil spring in the body of the handle. When the capsule is placed in the receptacle of the



FIG. 3. Anteroposterior (*A*) and lateral (*B*) roentgenograms showing multiple sources of radium within a large uterus, with several capsules resting transversely against the fundus.

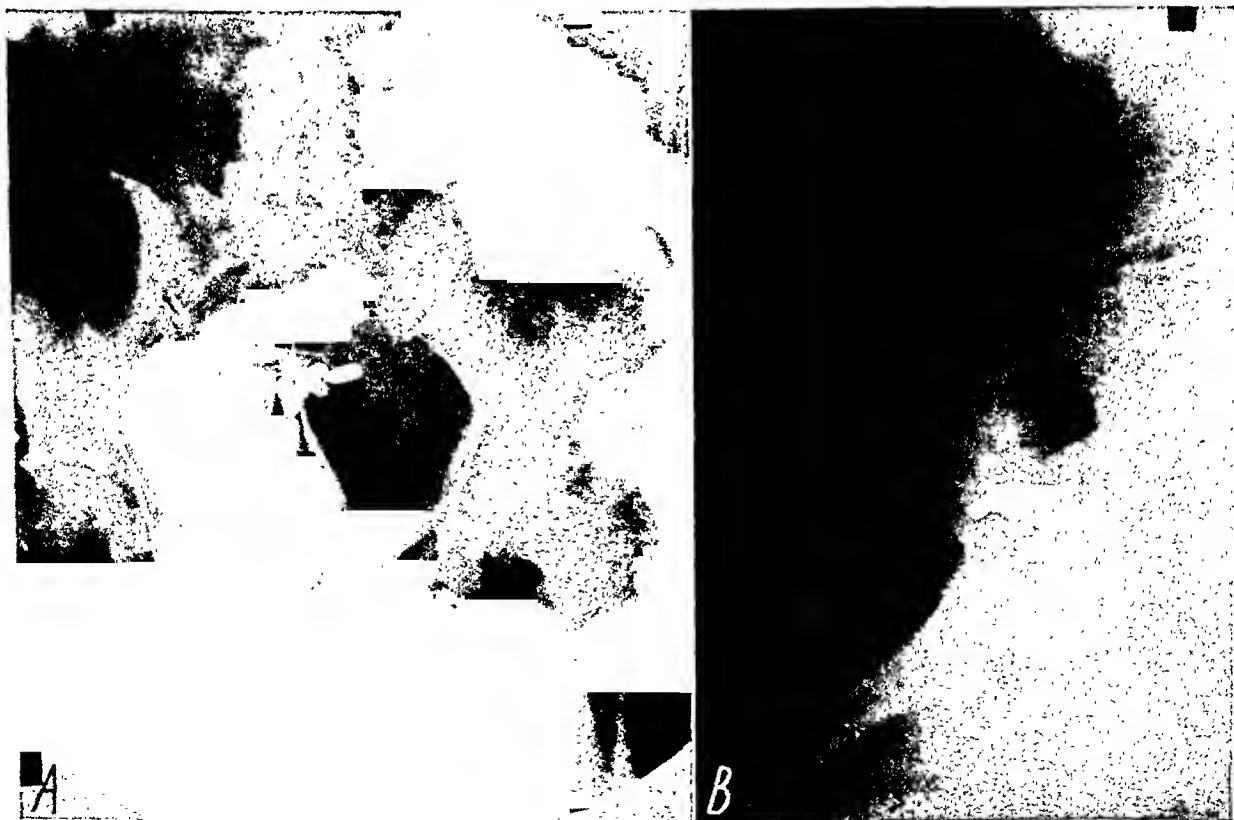


FIG. 4. Anteroposterior (*A*) and lateral (*B*) roentgenograms showing multiple sources of radium within a uterus of average size.

insertor and the wire loop over the retaining post, the spring tension holds the capsule firmly until released.

The instrument thus assembled is inserted into the uterus to the desired position, the plunger pressed about one-quarter of an inch to release the wire from the retaining post and then pressed a similar distance to dislodge the capsule from the receptacle. Two insertors speed the process as one can be loaded as quickly as the other is inserted and emptied. Approximately ten capsules will fill the average size uterus.

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REFERENCES

1. FRIEDMAN, M. Treatment of carcinoma of corpus uteri; description of a new hysterostat. *Radiology*, 1940, 35, 28-35.
2. HEYMAN, J. Radiumhemmet method of treatment and results in cancer of the corpus of the uterus. *J. Obst. & Gynaec. Brit. Emp.*, 1936, 43, 655-666.
3. MARTIN, C. L. Radiation therapy in carcinoma of the fundus of the uterus. *South. M. J.*, 1940, 33, 135-144.
4. NOLAN, J. F., and ARNESON, A. N. Instrument for inserting multiple capsules of radium within the uterus in the treatment of corpus cancer. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 49, 504-515.
5. SCHMITZ, H., and SCHMITZ, H. E. Improved technique for radium treatment of carcinoma of uterine body. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1935, 34, 759-765.



IRRADIATION SICKNESS: HISTAMINE EFFECT TREATED WITH BENADRYL

A PRELIMINARY REPORT

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PATIENTS, ill with irradiation sickness as a result of deep roentgen therapy, are relieved of severe symptoms by administration of benadryl (beta-dimethylaminoethyl benzhydryl ether hydrochloride), a newly introduced antihistamine agent.* The degree and frequency of relief are so marked that it seems worth while to report preliminary results on a small series of cases.

The study of the present series of patients with irradiation sickness was initiated (1) because it was thought that a substance possessing antihistamine action, such as benadryl, might neutralize the activity of foreign proteins resulting from roentgen-ray disintegration of cells and thus be effective in controlling irradiation sickness and (2) because dramatic results were obtained when benadryl was administered in 2 cases of severe irradiation sickness. It was the latter which really precipitated our study, so it is worth while to consider them in detail.

CASE I. (Case I, Table I.) A female, aged forty, had undergone exploratory operation which revealed an inoperable papillary carcinoma of the ovary. She was referred for a course of deep roentgen therapy. After five treatments, irradiation had to be discontinued because of severe nausea, vomiting and diarrhea. A few days later she returned for further therapy. The following treatment plan was instituted: 250 kv., Thoraeus filter, 50 cm. skin target distance, and 200 r to each of two fields daily. Irradiation sickness promptly developed despite use of the usual prophylactic measures including increased fluid, carbohydrate, and vitamin intake. Her condition became progressively severe; she began to miss appointments and finally was bedridden three days before she was able to

return for her seventh treatment. At that time she was given her usual daily dose of roentgen radiation and this was followed by intravenous injections of 10 cc. of benadryl (100 mg.). The immediate reaction to the injection simulated alcoholic intoxication. She became dizzy and drowsy, with unsteady gait, blurred vision, and slurred speech. The patient was kept in the clinic until intoxication subsided (three hours) and then sent home accompanied by a relative. She returned the following day, manifesting a most amazing change in condition. Nausea, vomiting and diarrhea had ceased; appetite and strength had returned. A change of personality occurred which was reflected by renewed interest in personal appearance and in her home. The patient was able to complete the roentgen treatment schedule without recurrence of irradiation sickness. While psychic elements may have played a rôle in her recovery from irradiation sickness, there were no reasons to suspect them, and thus, no attempt was made to exclude them.

CASE II. (Case II, Table I.) The second patient, an ambulatory female, aged forty-six, treated for a similar condition and by similar methods, developed extremely severe diarrhea, with marked anorexia, weakness and nausea. Intravenous injection of 10 cc. of benadryl (100 mg.) promptly stopped the diarrhea despite the fact that this patient had 25 stools during the preceding six hours. She likewise showed a striking improvement in morale which persisted throughout the balance of deep roentgen treatments.

METHODS AND PROCEDURES

Encouraged by these results we began routine use of benadryl in treatment of patients who developed definite symptoms of irradiation sickness. All other methods of therapy used previously for irradiation sickness were discontinued and the 19 cases reported in Table I are indicative of the

* Supplied for investigational purposes only by Parke, Davis and Company.

TABLE I
SUMMARY OF CASES OF IRRADIATION SICKNESS TREATED WITH BENADRYL

Case	Diagnosis	Deep Roentgen Therapy; Region Treated; Dates	Date	Symptoms					Reaction
				Ano- rexia	Nausea	Vomit- ing	Weak- ness	Head- ache	
I	Carcinoma of ovary	Pelvis 1-29-46 to 2-14-46	2- 1-46	+++	+++	+++	+++	++	Diarrhea
			2- 6-46	+++	+++	+++	+++	++	
			2- 6-46	Benadryl intravenous 10 cc. 100 mg.					Sleepy, dizzy weak
			2- 7-46	+	o	o	+	o	Marked improve- ment; no diarrhea
			2- 8-46 2-14-46	+	o	o	+	o	
II	Carcinoma of ovary	Pelvis 1-29-46 to 2-25-46	2- 6-46	++	+	o	++	o	Severe diarrhea
			2- 7-46	++	+	o	++	o	
			2- 7-46	Benadryl intravenous 10 cc. 100 mg.					Vision hazy; walk- ing unsteady; weak; drowsy
			2- 8-46	o	o	o	o	o	Marked improve- ment; no diarrhea
			2-18-46 2-23-46	+	+	+	o	+	
III	Recurrent carcinoma of breast, terminal stage	Breast; thoracic spine; neck 1-28-46 to 2-21-46	2- 8-46	++	++	o	++	++	
			2-13-46	++	++	o	++	o	
			2-14-46	++	++	o	++	o	
			2-15-46	Benadryl intravenous 10 cc. 100 mg.					Dizzy, sleepy, weak, apprehensive
			2-16-46	+	+	o	++	o	Improved
			2-19-46	+	+	o	++	o	
			2-20-46	+	o	o	++	o	
			2-21-46	+	o	o	++	o	
IV	Carcinoma of tongue	Tongue 2- 2-46 to 3- 6-46	2- 9-46	++	++	++	+	o	
			2-10-46	++	++	++	++	o	
			2-11-46	++	++	++	++	o	
			2-11-46	Benadryl 2 capsules 50 mg. each					No reaction
			2-12-46	+	+	o	+	o	Improved
			2-12-46	Benadryl 4 capsules 50 mg. each					No reaction
			2-14-46	+	+	o	+	++	
			2-16-46	++	++	o	++	++	To ill to come for treatment
			2-16-46	Benadryl intravenous 10 cc. 100 mg. at home					Weakness, sleepy, dizzy
			2-18-46	+	+	o	+	o	Improved; able to complete the series
			2-19-46 3- 6-46	+	+	o	+	o	

Case	Diagnosis	Deep Roentgen Therapy; Region Treated; Dates	Date	Symptoms					Reaction
				Ano- rexia	Nausea	Vomit- ing	Weak- ness	Head- ache	
v	Carcinoma of ovary	Pelvis 1-29-46 to 2-19-46	2-9-46	++	++	+			
			2-10-46	+	o	+			
			2-11-46	+	++	++	++		
			2-12-46	Benadryl intravenous 10 cc. 100 mg.					Drowsy, weak
			2-13-46	o	o	o	o	o	Improved
			2-14-46	o	o	o	o	o	
			2-18-46	+	o	o	++	o	
			2-19-46	++	o	o	++	o	
vi	Carcinoma of breast	Breast 1-30-46 to 2-16-46	2-11-46	++	++	o			
			2-12-46	++	++	o			
			2-13-46	++	++	o			
			2-13-46	Benadryl 4 kapseals 50 mg. each					Drowsy
			2-14-46	o	o	o	o	o	Improved
			2-14-46	Benadryl 4 kapseals 50 mg. each					None
			2-15-46	o	o	o	o	o	
			2-16-46	o	o	o	o	o	
vii	Menopausal menor- rhagia	Pelvis 2-11-46 to 2-21-46	2-12-46	++	++	o	o	o	
			2-12-46	Benadryl 3 kapseals 50 mg. each					No reaction
			2-13-46	++	+	o	o	o	
			2-14-46	++	+	o	o	o	
			2-14-46	Benadryl intravenous 5 cc. 50 mg.					Dizzy, weak
			2-15-46	++	o	o	o	o	Improved
			2-18-46	++	++	o	o	+	
			2-19-46	+	+	o	o	o	Improved
			2-20-46	o	o	o	o	o	
			2-21-46	o	o	o	o	o	
viii	Lymphosarcoma	Cervical nodes; inguinal nodes; epi- gastrium 2-18-46 to 3-4-46	2-18-46	+	o	o	o	o	
			2-27-46						
			3-1-46	+	++	o	o	o	
			3-1-46	Benadryl 3 kapseals 50 mg. each					No reaction
			3-2-46	+	o	o	o	o	Improved
			3-4-46	o	o	o	++	o	

Case	Diagnosis	Deep Roentgen Therapy; Region Treated; Dates	Date	Symptoms					Reaction
				Ano- rexia	Nausea	Vomit- ing	Weak- ness	Head- ache	
IX	Carcinoma of breast	Breast and pelvis 2- 7-46 to 3- 1-46	2- 7-46	o	o	o	o	o	
			2-23-46						
			2-25-46	o	+	o	o	o	
			2-26-46	++	o	o	o	o	
			2-28-46	++	++	o	o	o	
			2-28-46	Benadryl 3 kapseals 50 mg. each					No reaction
			2-29-46	+	o	o	+	o	Improved
X	Carcinoma of cervix	Pelvis 2-25-46 to 3- 7-46	3- 1-46	+	o	o	+	o	
			2-26-46	o	o	o	o	o	
			2-27-46	o	o	o	o	o	
			2-28-46	o	+	o	o	o	
			3- 1-46	o	o	o	o	o	
			3- 2-46						
			3- 4-46	o	+	o	o	o	
			3- 5-46	+	+	o	+	o	Diarrhea
XI	Carcinoma of cervix	Pelvis 2-26-46 to 3-15-46	3- 6-46	Benadryl 3 kapseals 50 mg. each					No reaction
			3- 7-46	o	o	o	+	o	Improved; no diar- rhea
			2-26-46	o	o	o	++	o	
			2-27-46	+	o	o	++	o	
			2-28-46	+	+	+	++	o	
			2-28-46	Benadryl 3 kapseals 50 mg. each					No reaction
			3- 1-46	++	+	o	++	o	No improvement
			3- 1-46	Benadryl 3 kapseals 50 mg. each					No reaction
			3- 2-46	o	+	o	+	o	Improved
			3- 4-46	++	++	++	++	++	
			3- 4-46	Benadryl 3 kapseals 50 mg. each					No reaction
			3- 5-46	+	+	o	o	+	Improved
			3- 5-46	Benadryl 3 kapseals 50 mg. each					No reaction
			3- 6-46	++	+	o	+	+	No improvement
			3- 7-46	++	+	o	+	+	

Case	Diagnosis	Deep Roentgen Therapy; Region Treated; Dates	Date	Symptoms					Reaction
				Ano- rexia	Nausea	Vomit- ing	Weak- ness	Head- ache	
XII	Carcinoma of breast with bone metastases	Spine 3-11-46 to 3-18-45	3-13-46	++	++	++	++	+	
			3-14-46	Blood specimen at 11:50 A.M.					
				Benadryl intravenous 15 cc. 150 mg.					
				Blood specimen at 1:00 P.M.					
			3-18-46	++	++	++	++	+	No improvement
			3-18-46	Benadryl intravenous 10 cc. 100 mg.					Drowsy
				Benadryl 1 kapscal 50 mg.					
			3-19-46	+	+	+	++	+	
			3-19-46	Benadryl 2 kapsals 50 mg. each					No reaction
			3-20-46	+	o	o	+	o	Improved
			3-20-46	Benadryl 3 kapsals 50 mg. each					No reaction
			3-21-46	o	o	o+	+	o	
			3-22-46	+	++	o	+	o	
			3-22-46	Benadryl 3 kapsals 50 mg. each					No reaction; im- proved
			3-23-46	Benadryl 3 kapsals 50 mg. each					
			3-24-46	Benadryl 3 kapsals 50 mg. each					
			3-25-46	o	o	o	+	o	
XIII	Carcinoma of tonsil	Tonsil 2-18-46 to 3-25-46	3-13-46	++	o	o	o	o	
			3-14-46	++	o	o	o	o	
			3-15-46	++	++	o	o	o	
			3-15-46	Benadryl 2 kapsals 50 mg. each					No reaction
			3-16-46	++	o	o	o	o	Improved
			3-16-46	Benadryl 1 kapsal 50 mg. each					No reaction
			3-18-46 3-25-46	+	o	o	o	o	Improved
XIV	Menorrhagia	Pelvis 3-11-46 to 3-14-46	3-11-46 3-12-46	o	o	o	++	o	
			3-13-46	++	++	+	++	+	
			3-14-46	Benadryl 3 kapsals 50 mg. each					No reaction
			3-14-46	+	o	o	o	+	Improved
XV	Menorrhagia	Pelvis 3-20-46 to 3-22-46	3-21-46	o	+	o	o	+	
			3-22-46	+	++	o	o	++	
			3-22-46	Benadryl 2 kapsals 50 mg. each					No reaction
			3-23-46	++	++	++	o	++	No improvement
			3-23-46	Benadryl 1 kapsal 50 mg. each					Did not return

Case	Diagnosis	Deep Roentgen Therapy; Region Treated; Dates	Date	Symptoms					Reaction
				Ano- rexia	Nausea	Vomit- ing	Weak- ness	Head- ache	
xvi	Hodgkin's disease	Abdomen 3-21-46 to 3-26-46	3-22-46	o	++	o	o	+	
			3-22-46	Benadryl 2 kapsels 50 mg. each					No reaction
			3-23-46	+	++	++	o	+	
			3-23-46	Benadryl 3 kapsels 50 mg. each					No reaction
			3-24-46	Benadryl 3 kapsels 50 mg. each					
			3-25-46	o	+	o	o	o	Improved
xvii	Carcinoma of cervix	Pelvis 3-25-46 to 4-6-46	3-26-46	o	+	o	+	o	
			3-27-46	o	+	o	+	o	
			3-27-46	Benadryl 2 kapsels 50 mg. each					No reaction
			3-28-46	o	o	o	o	o	Improved
			3-28-46	Benadryl 3 kapsels 50 mg. each					
			3-29-46	o	o	o	o	o	
			3-29-46	Benadryl 1 kapsel 50 mg. each					
xviii*	Postoperative carcinoma of ovary	Pelvis 4-13-46 to 5-1-46	4-15-46	++	++	++	++	o	
			4-16-46	++	++	++	++	o	
			4-16-46	Benadryl 2 kapsels 50 mg. each					No reaction
			4-17-46	+	+	o	+	o	Improved
			4-17-46	Benadryl 3 kapsels 50 mg.					No reaction
			4-18-46	o	o	o	o	o	
			4-18-46	Benadryl 1 kapsel 50 mg.					No reaction
			4-19-46	o	o	o	o	o	
			4-25-46						
xix	Lymphoblastoma	Neck and axilla 4-2-46 to 4-26-46	4-17-46	++	++	o	o	o	
			4-17-46	Benadryl 1 kapsel 50 mg.					No reaction
			4-18-46	+	+	o	o	o	Improved
			4-18-46	Benadryl 2 kapsels 50 mg.					No reaction
			4-19-46	+	o	o	o	o	
			4-20-46	o	o	o	o	o	

* Case xviii had a second attack of irradiation sickness on April 29, 1946, with nausea, vomiting, anorexia and weakness. She was given 6 kapsels of benadryl, with instructions to take them one-half hour before each meal. She was much improved on April 30, and except for weakness, there were no more complaints. She finished her series May 1. This patient was a small, thin individual, and as was expected, developed diarrhea near the end of the therapy series. Benadryl did not relieve the diarrhea.

results obtained by means of benadryl therapy alone. Our omission of other supportive therapy for the condition does not imply that benadryl should be or must be used alone; on the contrary, measures such as increased fluid and vitamin intake can be

continued with the benadryl. We used benadryl alone merely to evaluate the results more accurately. The chief complaints of these patients were anorexia, nausea, vomiting, weakness and headache. Since these symptoms appear consistently in

cases of irradiation sickness only the relief of these symptoms was used as an index of the efficacy of benadryl. The drug has not been employed as a prophylactic.

Both oral and intravenous administration of benadryl were tried. At first, the intravenous method was used; later benadryl by mouth gave relief and because of its simplicity and convenience, the oral method was used exclusively in the final 7 cases. The specific doses employed were arrived at by trial and error; and while they gave satisfactory results in most instances, better results may be forthcoming provided the quantity of benadryl and the time of absorption are evaluated more carefully.

For intravenous injections, 5 to 10 cc. (50 to 100 mg.) of benadryl was given. These patients experienced a side-reaction which appeared immediately after the injection and lasted one to four hours. They became dizzy, unsteady in motion, weak and drowsy. Later they developed a general feeling of wellbeing, as evidenced by renewed interest in themselves and in things about them, which lifted them from the depressed state so typical of cancer patients. Ambulatory patients unaccompanied by relatives were not permitted to leave until the drug intoxication had subsided. Hospitalized patients presented no particular difficulty.

Benadryl was given by mouth in the form of 50 milligram kapseals. From three to fourteen kapseals were given, one every four hours during the day; these patients experienced no marked reaction from the drug. It is our impression from observations on this small series of cases that benadryl by mouth will yield the desired amount of relief in most cases of irradiation sickness.

RESULTS

Eighteen of the cases summarized in Table I were improved by benadryl. The one exception, Case xv, disappeared from observation, and consequently the results of benadryl therapy are unknown. The degree of relief varied from patient to patient; in all but one instance (Case xiv), the patients felt well enough to continue their

daily roentgen treatments without interruption.

After administration of fourteen kapseals of benadryl, marked symptoms of irradiation sickness persisted in Case xiv. He became too weak to come to the hospital so 10 cc. of benadryl (100 mg.) were given intravenously at his home. Two days later his condition had improved and he was able to come daily for roentgen treatments and to complete the series without further interruption. The difficulty of evaluating all of the factors having a rôle in production of irradiation sickness is well illustrated by this patient. He was treated for carcinoma of the tongue using two external fields, one on each side of the face, and one intraoral field. The lesion was only about 3 cm. in diameter and there was not extensive nor rapid destruction of malignant tissue with resultant absorption of toxic end products. We had a feeling that there was a very strong psychogenic factor as the chief cause of this patient's illness and hesitated to use benadryl. This patient represents the poorest response to treatment by this method.

DISCUSSION

The fundamental causes and mechanism of irradiation sickness are not known and therefore methods of treatment thus far proposed have met with little significant success, although irradiation sickness has harassed radiologists since roentgen rays and radium were first utilized as therapeutic agents. The wide variety of etiologic factors elicited from review of the literature attests the lack of fundamental knowledge of the condition. Improvement in roentgenologic equipment has excluded such factors as static electricity and the inhalation of noxious gases such as ozone.¹⁹ To correlate other alleged etiologic mechanisms of irradiation sickness and arrive at a single causative agent is perhaps impossible. Two main categories of phenomena become apparent in tabulating all of the suggested causes of this condition. First and most prominent are those causes directly attributed to metabolic disturbance. These include such reported factors as

changes in sodium, calcium and potassium metabolism,^{1,13} disturbances in blood cholesterol¹¹, glycogen "dwindling,"¹⁸ enzymatic stimulation,⁷ choline poisoning,¹⁴ the general debility and cachexia of the patient,²¹ and the faulty absorption of certain vitamins.^{9,15,23} Suggested therapeutic agents and procedures based on these etiologic theories have met with little acceptance although many radiologists routinely follow the suggested measures to improve fluid, carbohydrate and vitamin intake for lack of anything more efficacious.

The second general grouping relates to shock. A most comprehensive discussion of this mechanism is that by Jenkinson and Brown.¹⁰ The theory of increased capillary permeability with its resultant influence on circulation producing the symptoms of irradiation sickness is supported by considerable experimental evidence. Their approach to therapeusis is directed to an intermediate point in the mechanism—the increased capillary permeability. This was accomplished by the use of amphetamine and d-desoxyephedrine.

The basis of this study and the theoretical explanation of results rests upon the contention that histamine-like bodies are developed in the blood of patients subjected to roentgen therapy and upon the hypothesis that benadryl by virtue of its antihistamine action, neutralizes these H-substances.

That active histamine-like substances are developed, or increased, in the blood is substantiated by extensive experimental studies both in animals and in man. Best and his co-workers² found histamine-like bodies, consisting partly of histamine itself, in certain tissue extracts. These bodies are present in tissues, and when tissues are irradiated, the H-substances are liberated from the cells and thus may enter the blood. Cramer⁵ has detected them in fresh blood samples. Beutel and Klein³ studied various effects of H-substances in circulating blood and found them among an increased capillary permeability. Michaelis¹⁶ showed a capillary dilatation remote from the area

of roentgen exposure. Pansdorf and Nell¹⁷ believe that dilatation of capillaries accounts for the fall in blood pressure following roentgen therapy.

The theory of histamine-like bodies in the circulation is supported further by the formation of gastric ulcers following intensive irradiation. Histamine, which cause hypersecretion and hypermotility of the stomach, has actually produced ulcers in the stomach of guinea pigs.⁴ More recently Forfota and Karaday⁸ have found other signs of the presence of H-substances in the circulation. Changes in blood pH and associated changes in blood mineral levels can be ascribed to these substances. Thus the H-substances are demonstrated to have an important rôle in the systemic effects of roentgen therapy.

The use of benadryl in the treatment of a variety of known allergic diseases has been widely reported. Curtis and Owens⁶ found that patients suffering from urticaria experienced prompt relief of symptoms as long as benadryl was taken. Other observations on benadryl as an antihistamine agent have been reported by Wells, Morris, Bull and Dragstedt²¹, by Shaffer, Carrick and Zackheim²⁰ and by McElin and Horton.¹² The rationale of all of this work has been the suppression of the histamine factor.

Determinations of blood histamine on these patients were desirable; this was possible in only one instance. Samples of blood were taken from this patient after moderately severe symptoms of irradiation sickness had developed. The histamine level was so high that errors of determination were suspected; but we were unable to check it. This, however, has provided an impetus to further study and experiments; tests are now in progress on both patients and animals.

CONCLUSIONS

1. Irradiation sickness is a condition manifesting many of the characteristics of histamine toxicity.
2. It is postulated that histamine may be produced as a result of aberrations in cel-

lular metabolism and tissue destruction following radiation therapy.

3. The use of benadryl as an antihistaminic substance in the treatment of irradiation sickness is efficacious in a high percentage of cases. Intravenous use of the drug is followed by the most dramatic response, good clinical results are also obtained from oral administration of benadryl.

4. On the basis of successful relief of symptoms by benadryl therapy of allergic diseases and in irradiation sickness, and on the basis of benadryl's antihistaminic action in both groups of diseases, it is suggested that irradiation sickness may be an allergic phenomenon.

5. The cerebral depression so common in patients suffering from malignant disease and often accentuated during radiation therapy may be a toxic manifestation of elevated blood histamine. Marked improvement in the mental condition of patients in this series supports this hypothesis.

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REFERENCES

1. ADLER, K. Weitere Untersuchungen über den Mineralstoffwechsel bei Röntgenbestrahlung. *Strahlentherapie*, 1932, 45, 563-570.
2. BEST, C. H., and others. Nature of the vasodilator constituents of certain tissue extracts. *J. Physiol.*, 1927, 62, 397-417.
3. BEUTEL, A., and KLEIN, O. Ueber den Nachweis von capillarpermeabilitätssteigernden Stoffen im Blute nach Röntgenbestrahlung. *Ztschr. f. klin. Med.*, 1933, 123, 104-110.
4. BÜCHNER, F., SIEBERT, P., and MOLLOY, P. J. Ueber experimentell Erzeugte akute peptische Geschwüre des Rattenvormagens. *Beitr. z. path. Anat. u. z. allg. Path.*, 1928, 81, 391-425.
5. CRAMER, H. Studien zur biologischen Wirkung der Röntgenstrahlen. *Strahlentherapie*, 1928, 28, 431-481.
6. CURTIS, A. C., and OWENS, B. B. Beta-dimethylamino-ethyl benzhydryl ether hydrochloride (benadryl) in treatment of acute and chronic urticaria. *Univ. Hosp. Bull., Ann Arbor*, 1945, 11, 25-26.
7. DEUTSCH, L. Ueber die Wirkung der Röntgenstrahlen auf die Katalase des Blutes. *Strahlentherapie*, 1933, 48, 114-117.
8. FORFOTA, E., and KARADAY, S. Ueber die biologische Allgemeinwirkung der Röntgen-

strahlen vom Gesichtspunkte einer durch Histamin oder ähnlich wirkende Substanzen verursachten Schokwirkung. *Strahlentherapie*, 1937, 59, 258; 643.

9. IMLER, A. E., and WAMMOCK, H. Vitamin B₁ in irradiation sickness. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 43, 243-248.
10. JENKINSON, E. L., and BROWN, W. H. Irradiation sickness; hypothesis concerning the basic mechanism and a study of the therapeutic effect of amphetamine and dextro-desoxyephedrine. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 51, 496-503.
11. LEVY-DORN, M., and BURGHEIM, F. Zum Einfluss der Röntgenstrahlung auf den Cholesteringehalt im Blute des gesunden und kranken Körpers. *Strahlentherapie*, 1926, 22, 538-549.
12. McELIN, T. W., and HORTON, B. T. Clinical observations on the use of benadryl; a new antihistamine substance. *Proc. Staff Meet., Mayo Clin.*, 1945, 20, 417-429.
13. MARKOVITS, E. Prophylaxis and treatment of roentgen nausea. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1928, 20, 559.
14. MARTIN, C. L., and MOURSUND, W. H., JR. Irradiation sickness. *Radiology*, 1938, 30, 277-284.
15. MAXFIELD, J. R., JR., McILWAIN, A. J., and ROBERTSON, J. E. Treatment of radiation sickness with vitamin B₆ (pyridoxine hydrochloride). *Radiology*, 1943, 41, 383-388.
16. MICHAELIS, LEONCR. Oxydations-Reductions-Potentiale. J. Springer, Berlin, 1929.
17. PANSDORF, H., and NELL, W. Die Blutdruckschwankungen nach Röntgenbestrahlungen und ihre klinische Bedeutung. *Strahlentherapie*, 1930, 38, 40-53.
18. ROTHER, J. Ueber den Angriffspunkt der Röntgenstrahlenwirkung am biologischen Objekt. *Strahlentherapie*, 1928, 27, 197-256.
19. SCHREINER, B. F., and STENSTRÖM, K. W. Consideration of assumed causes of roentgen-ray intoxication and injuries. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1924, 11, 451-454.
20. SHAFFER, L. W., CARRICK, L., and ZACKHEIM, H. S. Use of benadryl and related dermatoses. *Arch. Dermat. & Syph.*, 1945, 52, 243.
21. STEINBERG, S. S. Irradiation sickness; critical study. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1942, 47, 56-65.
22. WELLS, J. A., MORRIS, H. C., BULL, H. B., and DRAGSTEDT, C. A. Observations on nature of antagonism of histamine by β -dimethylamino-ethyl benzhydryl ether (benadryl). *J. Pharmacol. & Exper. Therap.*, 1945, 85, 122.
23. WHITMORE, W. H. Prevention of irradiation sickness; use of vitamin B₁ in roentgen therapy. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 49, 83-98.

SOME HISTORICAL DATA RELATING TO THE DISCOVERY OF THE ROENTGEN RAYS

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RECENTLY it has been my privilege to make several postwar visits to Würzburg¹ to carry out some investigations bearing on the discovery of the x-rays, which was made just fifty years ago in November, 1895, by Wilhelm Conrad Röntgen. The present director of the Physical Institute and Professor of Physics, Dr. Friedrich Harms, and his assistants² have been very helpful and willing to add any information they could to the story of Röntgen already so well told by Glasser.³ One would think, after all these years, that little more would be left to be said, but it appears that in the time just preceding and during the war years (1933-45), there has been considerable controversy, with the help of the Nazi press and some party members, over the position of Röntgen in the annals of science.

Articles appeared in the daily papers in such organs as *Völkischer Beobachter*, *Das Schwarze Korps* and others suggesting that Röntgen had done nothing remarkable, but merely had carried to its inevitable conclusion, a bit precociously perhaps, the work of the great Aryan Scientist, Philipp Lenard† (Fig. 1). Director of the Physical Institute at Heidelberg University.‡ To the students at Würzburg these stories seemed a bit at variance with what Dr. Harms had been teaching them of Röntgen's discovery, so to clarify the history and answer their questions additional information was brought to light. Prof. Johannes Stark, as

they all knew, was President of Hitler's Physical and Technical Reichsinstitute in Berlin and, with Lenard, was a top ranking Nazi scientist. In an article⁴ eulogizing Stark on his seventieth birthday, Lenard tells of Stark's researches when, as successor to Röntgen as director of the Physical Institute at Würzburg (1920-1921), he refers to the "dark history" of the burning of Röntgen's notes concerning his discovery and implies that there was something hidden from view. Earlier (1935) Stark had had written a paper⁵ minimizing the rôle of Röntgen in the discovery of the rays which bear his name, and attributed the discovery to the coincidence of three accidental circumstances of which more will be said later. In the same edition of the periodical, F. Schmidt,⁶ Assistant Professor of Physics at the Reichsinstitute in Berlin, proved to his own satisfaction that Lenard had indeed already made notes of x-ray effects when experimenting with his cathode-ray tube, but as sagely observed by Max Wien,⁷ the Assistant of Röntgen 1893-1895, "He did not investigate these effects and he did not publish anything about them. Under other conditions, more favorable, Lenard perhaps could have observed stronger effects, and then he would have been the discoverer of X-rays—." So it was during the years of the Nazi ascendancy that Lenard, Stark, Schmidt and others engaged in a mutual admiration society, and in the case of Lenard, at the expense of the fame of Röntgen.

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¹ Etter, L. E. Post-war visit to Röntgen's laboratory. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 54, 547-552.

² Prof. Dr. Heinrich Ott. Privatdozent Dr. Karl Gailer.

³ Glasser, Otto. W. C. Röntgen and the Discovery of the Roentgen Rays. J. Springer, Berlin, 1931; Charles C Thomas, Springfield, Illinois, 1934. Also, Dr. W. C. Röntgen, Charles C Thomas, Springfield, Illinois, 1945.

† Zehn Kameraden, Philipp Lenard, der Deutsche Naturforscher, Sein Kampf um nordische Forschung. J. F. Lehmanns Verlag, München, 1937.

‡ "The Philipp Lenard Institute."

⁴ Lenard, P. Johannes Stark zum Geburtstag, April 15. *Völkischer Beobachter*, No. 106, April 14, 1944.

⁵ Stark, J. Zur Geschichte der Entdeckung der Röntgenstrahlen. *Phys. Ztschr.*, 1935, 36, 280-283.

⁶ Schmidt, F. Über die von einer Lenard-Fensteröhre mit Platinansatz ausgehenden Röntgenstrahlen. *Phys. Ztschr.*, 1935, 36, 283-288.

⁷ Wien, Max. Zur Geschichte der Entdeckung der Röntgenstrahlen. *Phys. Ztschr.*, 1935, 36, 536.

As remarked by Glasser⁸ in his newly published book the attitude of Lenard about Röntgen has seemed enigmatical. Bringing a great deal of light to this subject are some letters between Lenard and Röntgen preserved in a safe at the Physical Institute at Würzburg, written statements by Lenard in his most recently published work⁹ and direct statements made to me on the occasions of two interviews with Lenard. The letters, of which several photostatic copies were made and sent to a few German scientists for safe keeping during the war, have not been made public until this time. The Physics Department feared the Nazis would get hold of the originals and destroy them as the only incontrovertible evidence existing of the true facts in the controversy of Lenard vs. Röntgen. Röntgen must have sensed that some day there would be a need of these letters or else he would have had them destroyed, as directed in his will, with the other papers concerning his work. On the envelope enclosing the correspondence Röntgen had written, "Letters from P. Lenard—of some interest in the judgment of the writer." These are the letters spoken of in Röntgen's letter to Zehnder¹⁰ where he says, "I was astonished while going over my old letters to find some written by Lenard that show a friendly attitude toward me, which however, stopped completely about the time Wien succeeded me in Würzburg and I received the Nobel Prize." Indeed these letters do show a friendly attitude even in the first one from Bonn (Fig. 2) where Lenard responded to Röntgen's request for information about the source of aluminum windows for the tube by sending him two of the scarce items from his own store. The letter from Röntgen (Fig. 3) disclaiming any knowledge of, or responsibility for, the unkind remarks of Zehnder, was answered by a very informative one from Lenard (Fig. 4)



FIG. 1. Photograph of P. Lenard on his eightieth birthday, 1942. Translation of note on back: "Dr. Etter, the representative of the conqueror, with thanks for his scientific interest. Messelhausen, 20 Sept. 45. P. Lenard"

in which he makes the extremely revealing statements, "Because your great discovery caused such remarkable attention in the farthest circles my modest work also has come into the limelight, which was of particular luck for me, and I am doubly glad to have had your friendly participation—especially through the presence of the ray discovered by you—" Even the last letter of the group (Fig. 5) shows a continued amiable spirit with a request from the young scientist Lenard for an assistant trained by the older man.

What then changed the attitude of Lenard from that shown above to his openly antagonistic attitude toward Röntgen and his discovery? It will be seen from the foregoing letter to Zehnder¹⁰ that Röntgen attributed the change to his receipt of the Nobel Prize and, for all we know, that may have been the beginning.

⁸ Glasser, Otto. Dr. W. C. Röntgen. Charles C Thomas, Springfield, Illinois, 1945.

⁹ Lenard, P. Wissenschaftliche Abhandlungen. Band III. S. Hirzel, Leipzig, 1944.

¹⁰ Zehnder, Dr. Ludwig. W. C. Röntgen. Briefe an L. Zehnder. Rascher & Cie, Zürich, 1935.

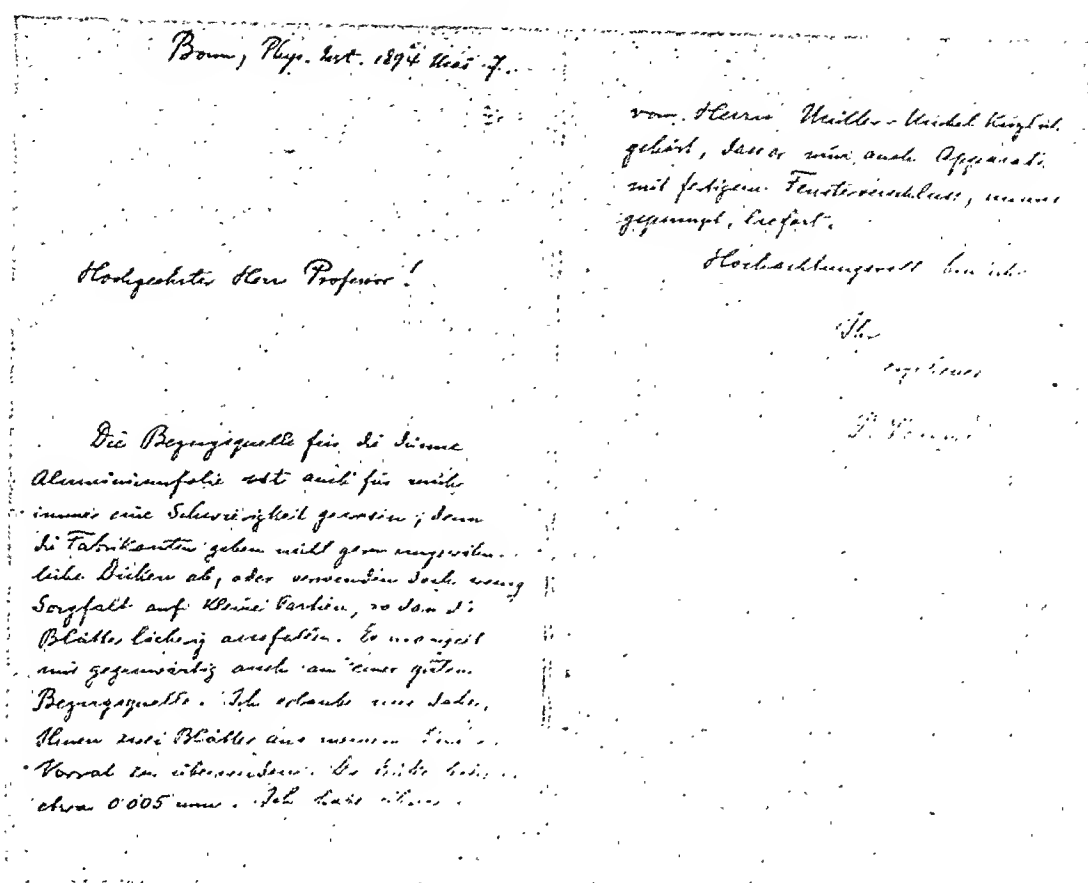


FIG. 2. Letter from Lenard to Röntgen, Bonn, May 7, 1894 (with translation).

Bonn, Phys. Inst., 7 May '94

HIGHLY ESTEEMED PROFESSOR:

The source for thin Aluminum sheets presents great difficulties for me too, since the manufacturers hesitate to give up unusual sizes (thicknesses) or they take little care with small parts, so that the sheets turn out full of holes. I too am lacking a good source of Al. I permit myself to send you two sheets from my supply. The thickness is about 0.005 mm. By the way I have heard lately from Mr. Müller-Unckel that he is manufacturing apparatus with a complete window and not evacuated.

With high esteem I am
Your obedient,

P. LENARD

Certainly a deprecating estimate of Röntgen's rôle in the discovery of the x-rays was given by Lenard in his own Nobel Prize Lecture in 1905¹¹ when he says, "In this tube (of mine) the intensified cathode rays meet on the large surface of the platinum, that metal which we all know now transforms them—as wasn't known at that time—into Röntgen's rays. . . . However, given this tube, the attention of the observer, already diverted from the inside to the outside . . . it seems to me that the discovery at this stage of the development appears to follow automatically." Along the

same line Lenard is reported to have said at about this time "that anyone who was wideawake and using a Lenard tube could have discovered the x-rays." The obvious question then is, "Why didn't Lenard discover them?" His answer is fourfold.^{12,13} First, he was engaged at the time in moving

¹¹ Lenard, P. Wissenschaftliche Abhandlungen. Vol. III. S. Hirzel, Leipzig, 1944.

¹² Freund, F. Lenard's share in the discovery of x-rays. *Brit. J. Radiol.*, March, 1946, 19. In this paper the author draws attention to the fact that Lenard noted fluorescent and photographic effects of cathode rays up to a distance of 8 cm. and failed to explain discharge of an electroscope up to 35 cm. Also he notes that while Lenard demonstrated the range of cathode rays in air to be only 8 cm., he did not explain the photographic effect he observed to have taken place through a sheet of cardboard. When Lenard missed the explanation of these seeming paradoxes he missed the discovery of x-rays.

¹³ Lenard, P. Wissenschaftliche Abhandlungen. Band III. S. Hirzel, Leipzig, 1944, footnote, p. 5.

from Bonn to Breslau and this upset his research. Second, he had encased his tube with a tin jacket to exclude the intrinsic light of the tube from the darkened room, better to observe fluorescence on the screen held before the aluminum window of the tube. Third, he had not used barium platinocyanide among the fluorescent substances tried because he did not have ready access to a supply of it that was in the hands of his superior, Prof. Hertz, but used instead pentadecylparatolylketon (keton). Hertz kept the keys* and young Lenard was not permitted to use anything he had a mind to use. In the fourth place Lenard states that he himself received an imperfect tube from the glassblower, Müller-Unckel, while Röntgen received one of the first tubes made perfectly. The last three of these circumstances are those given by Stark⁵ in his above mentioned paper as the accidental happenings bringing Röntgen the honor of the startling discovery. But it may well be questioned whether indeed all these happenings were simply accidental. That will be discussed later.

Meanwhile, permit me to give more in detail Lenard's personally stated position as of the present day. Having fled from Heidelberg on the near approach of our armies to a tiny village in Bavaria† Lenard sits today in his house ready to state his position clearly on his view of Röntgen. At the time of my first interview with him, September 6, 1945, he referred me for amplification of his remarks to his new four volume work published in part in Munich, of which three volumes are now off the presses.¹² The fourth has not yet been published as the printing plant was destroyed by bombing this year (1945). I obtained Volume III from his present doctor in a nearby village‡ and was surprised to find a note written and signed by P. Lenard on the fly-leaf saying, "To be found in this volume: My reckoning with Röntgen, held back for almost fifty years: p 65/66, 1 and

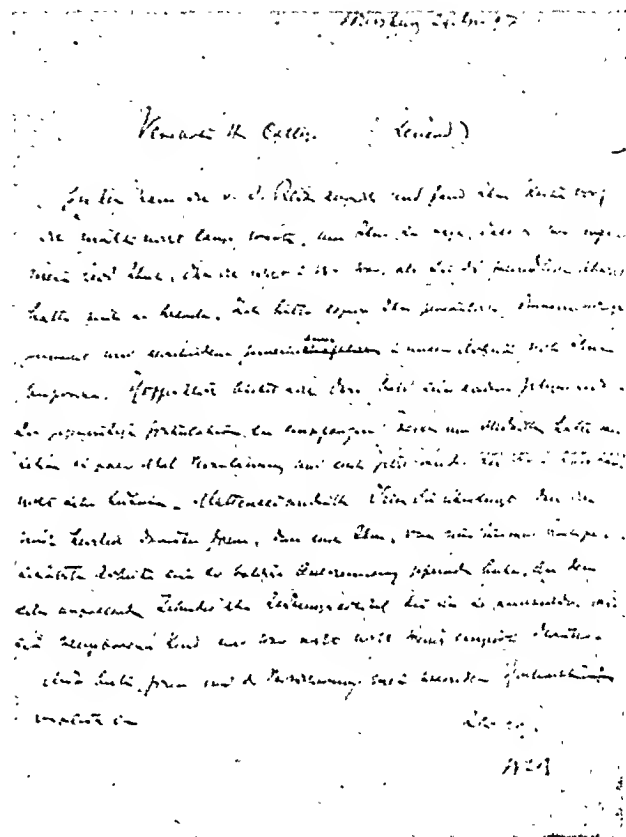


FIG. 3. Röntgen's letter to Lenard April 24, 1897 (with translation). This is a copy made by Röntgen of the letter he sent to Lenard. When queried about the friendly tone of this letter Lenard called it a "Katzenbrief."

Würzburg, 24 April 1897

ESTEEMED COLLEAGUE (LENARD):

Today I came back from travels and found your card. I won't hesitate longer to tell you how sorry I am I wasn't in Würzburg when you had the friendly intention to visit me. I would have liked to make your personal acquaintance to discuss with you various works of common interest. I hope there will soon be another opportunity to do so. For the receipt of prizes and medals we several times have had reason for mutual congratulations, and now again for the series of reprints in large numbers—not of great artistic value. Be assured that I am very happy that my work has found such a ready recognition from you. As to the untimely newspaper articles by Zehnder I am as innocent as a newborn child and was furious about it. With best regards and assertion of my highest esteem I remain yours,

W.C.R.

5, 69, 177/178. Again I speak now only because of my ineradicable desire for truth. For fifty long years one was so dull never to care seriously about the actual coming about of a rather much noticed and practically used discovery."

* Personal interview, September 20, 1945.

† Messelhausen.

‡ Dr. Emil Härtig, Grunsfeld, Bavaria.

"Discovery of electrons: p 1, 35, 73, 81, 197. Unlocking the atomic nucleus, p. 237/238, 250. Concerning a few Jews (Warburg, Rubens) and their rôle in Germany, p. 339, 297."

Upon reading the detailed references given one can very definitely understand Lenard's view of the discovery. It is given in part in no uncertain terms in a footnote on page 178, thus: "A comparison can best make clear to the neutral observer Röntgen's rôle in the discovery. I shall make this striking comparison here because it may throw a light on the even now widespread historical confusion and untruth! Röntgen was the midwife at the birth of the discovery. This helper had the good fortune to be able to present the child first. She can only be confused with the mother by the uninformed who knows as little about the procedure of the discovery and the preceding facts as children of the stork."

On the occasion of our second interview* he gave a slight variation of his view to be quoted thus, "I am the mother of the x-rays. Just as a midwife is not responsible for the mechanism of birth, so was Röntgen not responsible for the discovery of x-rays, which merely fell into his lap. All Röntgen had to do was push a button, since all the ground work had been prepared by me."** Further, he stated for quotation, "Without my help the discovery of x-rays would not have been possible even today. Without me the name of Röntgen would be unknown.

* September 20, 1945, also at Messelhausen.

** Lenard, P. Wissenschaftliche Abhandlungen, Vol. III—footnote p. 65—"the discovery must have been easy if not unavoidable for the head of a Phys. Inst. who had all the necessary equipment ready at hand."

Röntgen was an opportunist who sensed there was something to be found in experimenting with my tube which he carried out with an eye to fame... Hittorf developed the discharge tube first in 1869, and a little was added to it by Crookes in 1879. But nothing of great importance was added to it until my work twenty-five years later. I was always *too modest* and did not rush into print. In my letter to Röntgen (Fig. 4) where I praised him for his great discovery I thought he would reply that he really owed it all to me and my tube, but I waited for this acknowledgment from him in vain." Here† then is given the answer to the puzzle of Lenard's long smoldering antagonism to Röntgen.

Among the letters from Lenard preserved by Röntgen in the safe at Würzburg is also one from the chemist Krafft (Fig. 6) of Heidelberg, July 7, 1894, telling of his sending a supply of pentadecylparatolylketon (keton) to Röntgen. This gives the clue to Röntgen's use of barium platinocyanide. He knew this substance had slight fluorescent properties in ultraviolet light, and since he did not have any keton on hand at the time he received his Lenard tube (May, 1894) and wished to repeat Lenard's then recently reported experiments,¹⁴ he rea-

† Lenard, P. Wissenschaftliche Abhandlungen, Vol. III. Footnote p. 65. "However I thought for sure that Röntgen himself would express himself even more satisfactorily as to the origin of his discovery than he actually did... He even ordered the unseen burning of his manuscripts (1921) pointed out by him which originated from the period of the discovery and which was duly executed... Clearly understandable, I made it already in 1906 in a comment (Nobel Speech No. 10, Sec. 8) which Röntgen never disputed in these 17 remaining years of his life..."

¹⁴ Lenard, Philipp. Ueber Kathodenstrahlen in Gasen von atmosphärischem Druck und im äussersten Vacuum. *Ann. d. Phys.*, Jan., 1894, 51, 225.

not enough German copies are to be had). May I particularly point out that the subject of the discussion is nothing more than a weak hypothesis in my opinion. In the meantime, I have tried hard to establish new proofs of that hypothesis, though so far I've had no success. My work has been disturbed several times during the last year due to my moving. A short while ago I had repeated my former experiments with the cathode rays in the open air to find out whether my former experiments have been disturbed, *especially through the presence of the rays discovered by you*. However, I have found to my own satisfaction that this is not the case, but that the properties I gave my cathode rays apply really to these divertible rays. Perhaps it is possible for me very soon to present you with some printed matter on this subject.

Again I thank you with greatest respect, I remain sir,

Yours truly,

P. LENARD

soned, as any scientist might have done, that barium platinocyanide could serve as a substitute. So he set up Lenard's apparatus with the tin box enclosure, as described in his paper, and found that the screen made with a coating of barium platinocyanide fluoresced very well at the window of the Lenard tube, as he thought from the presence of cathode rays. Then, with the probity of genius, he tried this screen in proximity to his Hittorf tube and again noted fluorescence. Thinking he might be deceived by the intrinsic light of the tube he placed some black cardboard around it and tried the experiment again. When he still had fluorescence he could have concluded that barium platinocyanide was exceptionally good for demonstrating even very weak cathode rays that may after all have come through the glass and black paper. For, had he not seen the same fluorescence of the screen at the window of the Lenard tube where he had good reason to expect many cathode rays, as he now saw in the vicinity of the Hittorf tube? This was in May, 1894. In July he received the keton from Krafft, the partly emptied original vial of which is still in the laboratory at Würzburg. It is not known whether he continued his experiments then with cathode rays or waited until late summer or fall of 1895. But when he compared the effects of the tubes (Hittorf's, Lenard's, Crookes') on keton* and on barium platinocyanide screens he knew he was dealing with a new kind of ray and this was not merely accidental. Repeating the experiments, he found not even a faint effect on keton from

* A keton screen is made simply by melting a few crystals of the substance on a piece of paper with a little heat.

Heidelberg, 5/7/94.
 Hochgeachteter Herr!
 Beifolgend erlaube ich mir,
 Ihnen die durch Ihren Herrn
 Assistenten gewünschten 20 gr. Keton,
 die ich durch einen Praktikanten
 habe darstellen lassen, zu übersenden.
 Sollte das Präparat aus irgend
 einem Grunde den Erwartungen
 nicht entsprechen, dann könnte ich
 Ihnen noch einen kleinen Rest
 des festen Öls Dr. Lenard'sches
 Präparats zur Verfügung stellen.
 Vielleicht hat es auch größere oder
 geringere Reinheit als das aus heissem Alkohol
 leicht krystallisierende Präparat und es
 auf die Phosphoreszenz einwirken mag.
 Hochachtung vollendete F. Krafft

FIG. 6. Krafft's letter to Röntgen (with translation).

Heidelberg, 5 July '94

HIGHLY ESTEEMED SIR:

Enclosed I take the liberty of sending you through your assistants, 20 gr. of keton which you desired. Should this preparation for any reason not meet your expectations, then I could let you have the remainder of what was prepared for Dr. Lenard. Possibly because of the higher or lower purity of the preparation made from hot alcohol and being easier crystallized, it had some effect on the appearance of the fluorescence.

With great respect,
 F. KRAFFT

a new change has come. Should you be able to suggest a clean worker, then I would appreciate it very much. In any case, accept my best thanks beforehand for your trouble.

The Electrotechnic Institute here, which you kindly inquired about, is so far a mere idea, and I think is only a wish from Berlin. Anyway, it would be outside my activities. However, a new Physical Institute is being built here for me. So far I have troubles with it and it hurts me to be drawn away again and again from my work. I hope to have a good deal of pleasure in it someday. I hope that people won't think I have grown lazy since so little comes to light from me.

With best regards and hopes that this finds you in best health, I am always your very obedient

P. LENARD



FIG. 7. The cabinet in Röntgen's library in the Physical Institute, University of Würzburg, containing the historical collection. Original and only Lenard tube with which he experimented is shown outside the case, so placed by the Physics Faculty as symbolic of the fact that it was not essential in Röntgen's discovery.

the Hittorf tube incased in black carton, but good fluorescence with the barium platinocyanide. He even raised the tension on the order of 15 to 20 kv. trying to force the cathode rays through the glass walls,* but still no effect on the keton screen was observed. He noted the same effects with the Crookes tube. Then, substituting black carton paper for the tin box surrounding the Lenard tube, he found fluorescence of the keton screen only at the window and in no other position around the tube. But with the barium platinocyanide screen there was good fluorescence in all positions. It now became clear to Röntgen that cathode rays were completely absorbed by the glass walls of the Hittorf and Crookes tubes and could get out of the Lenard tube only

through the aluminum window; further, that the keton screen fluoresced only in presence of cathode rays and not in the rays that passed through the black carton. And he now knew why he had earlier obtained fluorescence with his barium platinocyanide screen in proximity to the Hittorf and Crookes tubes: all the activated tubes generated a new but powerful unknown ray that penetrated the glass walls and even thick black paper! Was this great discovery then merely accidental, or the climax of scientific research guided by the light of genius? The reader must be the judge.

Lenard claims that his tube and no others was responsible for the discovery,† and this because the platinum cylinder insert was such a good source of x-rays.¹²

* Röntgen was on the right track, since with sufficiently high kilovoltage (1,000 kv.) it is possible to force cathode rays through the glass, as is now known.

† Personal interview, September 26, 1945.

¹² Lenard, P. *Wissenschaftliche Abhandlungen*, Band III,

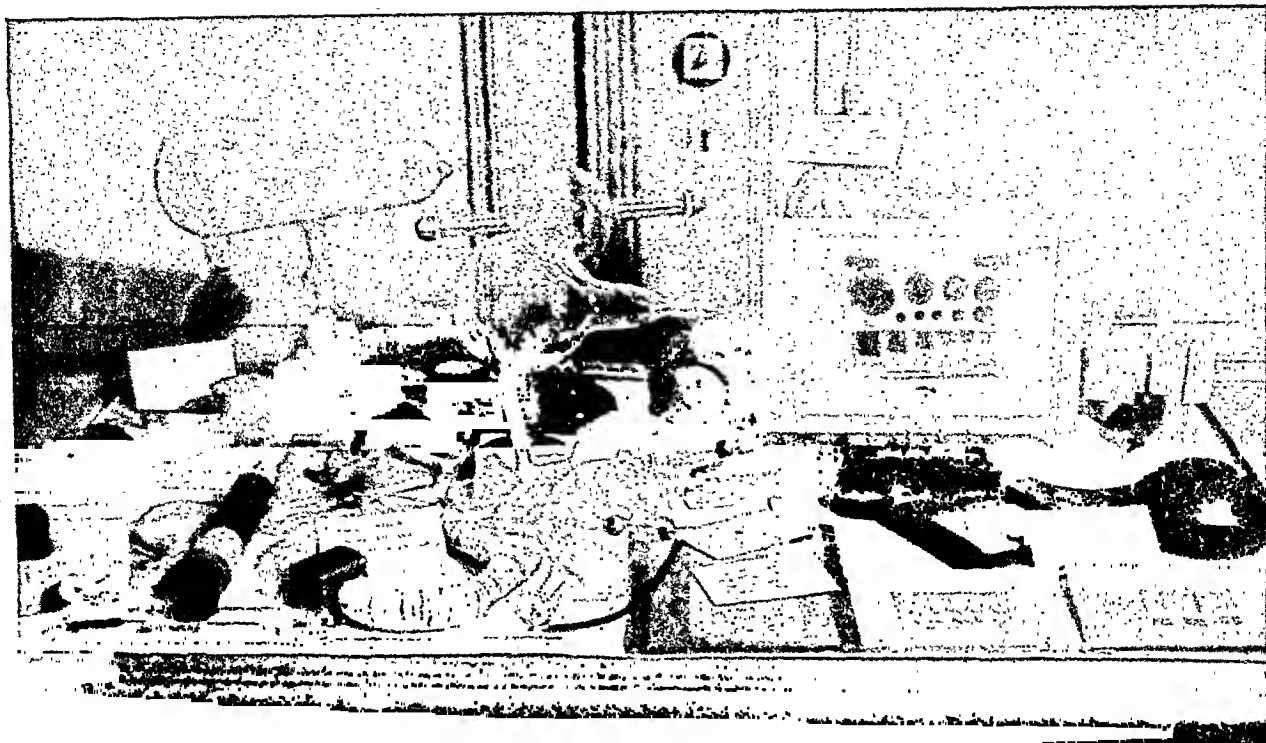


FIG. 8. Here shown are Crookes tube, left background, several Hittorf tubes in center, glass jar for ionization of air with print of box of weights standing against it; prisms along right edge with masks of lead and aluminum in right foreground. In left foreground at very edge an "absolute evacuated" tube (Röntgen used many of these) with electromagnet beside it.

However, the Würzburg Physical Institute's laboratory order book shows that only one Lenard tube was ever ordered (Fig. 7), but that beginning in September, 1895, many of the tubes called in the trade by Müller-Unckel "absolute evacuated" were ordered by Röntgen and used in his further study of the physical properties of

x-rays (Fig. 8). Röntgen did not stress the use of platinum as a means of transforming cathode rays to x-rays, but rather tried to get higher vacuum and to use higher kilovoltages (25–30 kv.) to secure more penetrating rays. This he was able to do with the "absolute evacuated" tubes. Röntgen freely stated that he used Lenard's tube and repeated his cathode-ray experiments, but did not ever say he used it to the exclusion of other types of tubes.* In his "Ueber

footnote p. 69. "It must have been known to Röntgen during his discovery attempts that platinum is especially effective in the production of the new rays, much more effective than glass on which the cathode rays fall in the common discharge tube. The tube with which he made his discovery was the one with a platinum insert (see below also footnote p. 5) but he also used a Crookes focus tube in which cathode rays also hit the platinum. However in his publications he does not go into detail either about the platinum or the type of tube which caused the discovery. . . . Only in a later communication, when satisfied with the properties of the new rays and when no one cared much for the history of the discovery, Röntgen mentioned platinum as especially effective, but without even then mentioning the tube with which the discovery was made."

Footnote p. 5. "That tube which Röntgen bought from the glassblower (Müller-Unckel) led him to the discovery of the new rays. At that time I was engaged in an extensive letter exchange with that glassblower in order to instruct him in the manufacture of a workable, unobjectionable tube for me, and Röntgen was very well the first buyer of that tube. The tube sent to me for trials, was very good, but worked only for a short time; it was dirty inside, spoiled the proper vacuum by generating gas, and through constant pumping out of air all comparative observations were made difficult. Nevertheless, I found with the tube signs of unknown occurrences taking place within the surroundings. Un-

fadable aircurrent effects were noticed up to 30 cm. in front of the window. As it is known now, these were the new rays generated by effects on the platinum. To follow up these observations I received the proper tube only later, at a time when all my experimental work had to be interrupted. (Caused by odd circumstances told in my not yet published "Erinnerungen"). Thus, Röntgen became the main beneficiary of my attempts to manufacture the tube which brought him the discovery of X-rays. Barium platinocyanide with which the above mentioned signs discovered by me could have been followed and interpreted was not available to me."

* Freund, in his article above referred to,¹³ also states that it can reasonably be assumed that Röntgen experimented with a Lenard tube because he wrote in "Ueber eine neue Art von Strahlen," ". . . and covers the Lenard apparatus with a tightly fitting coat of thin cardboard" and then crossed out "Lenard apparatus" and wrote instead "the tube." This hardly proved that Röntgen used the Lenard tube exclusively. In correcting his sentence Röntgen no doubt recognized he had named several tubes in the first phrase and that "the tube" would properly refer to any one of them.

eine neue Art von Strahlen"¹⁶ he says, "If one passes a high voltage current through a Hittorf, sufficiently evacuated Lenard, Crookes or other similar apparatus . . ." fluorescence of a barium platinocyanide coated screen in the vicinity of the tube can be observed in a darkened room. Indeed the very sequence in which the names are listed is given as evidence by the physics faculty at Würzburg of the order in which Röntgen first observed x-rays, and this is likely significant.

From what has been said it is evident that Lenard's attitude has been one of gradually developing and increasing animosity through the years, climaxed during the time of his lofty and commanding position in the Nazi hierarchy of scientists. This has been evidenced in many ways beginning with his Nobel Prize lecture. His book "Grosse Naturforscher" containing biographies of great scientists from Pythagoras through the lives of Hittorf, Crookes, Hertz, fails to mention Röntgen, except once incidentally,¹⁷ in the discussion of the work of Hittorf and Crookes thus: "The developments now came quickly one after another, the extent of which can only be signified briefly: The discovery of the high frequency rays (Röntgen-rays) followed . . ." A physics textbook edited by a student of Lenard's at Heidelberg—Tomaschek¹⁸—deals with x-rays in this brief note: "Röntgenstrahlen. In June, 1895, Röntgen made the observation with a Lenard cathode-ray tube, that on the part of the tube where the cathode rays are stopped new rays are given off that have the property of causing fluorescence of fluorescent material in the neighborhood of the tube and of blackening photographic paper beneath it!"—On page 35 of "Wissenschaftliche Abhandlungen" Lenard speaks, rather than of x-rays or of roentgen rays, of "the discovery of the new rays, that were soon very important in

medicine." In his four volume work "Deutsche Physik"¹⁹ there is no mention of Röntgen or Einstein in the text, but the foreword is a lengthy diatribe against the Jews. The implication, drawn by many persons in Germany during recent years, was that Röntgen was a Jew. In answer to my direct query, "Was Röntgen a Jew?," Lenard replied, "No, but he was a friend of Jews and acted like one." Showing further his bias on this subject is a note signed by Lenard on the fly-leaf of Volume 1 of "Deutsche Physik" in the library of the Physical Institute* at Heidelberg saying, "To the Philipp Lenard Institute—should there be room left—among the Jewish and Japanese ghosts."

Of particular interest at this time of the fiftieth anniversary of Röntgen's discovery is the fact that the Physical-Medical Society of Würzburg made application in 1944 to the Nazi Minister of Post and Telegraph to have a memorial stamp made for Röntgen similar to the one issued for Robert Koch and other scientists. But it so happened that the minister—Ohnesorge—had been a physicist and student of Lenard's at Heidelberg. He rejected the request saying the proposal was not in order inasmuch as such an honor was reserved only for the illustrious.

It is clear that Lenard embarked upon and continued a course designed to minimize the work of Röntgen, and to make him appear a bungler who merely happened to make a great discovery. His outstanding position as one of Hitler's "brain-trust" and director of the Physical Institute of one of Germany's great universities added great weight to what he had to say. So, in his intense nationalism, he claimed a lot for Germany and incidentally for himself when he says in "Wissenschaftliche Abhandlungen"²⁰ more about his tube and his cathode-ray studies, "... My researches led during the interruption of my work to the discovery of Röntgen, and then followed Bec-

¹⁶ Röntgen, W. C. Ueber eine neue Art von Strahlen (Vorläufige Mitteilung). Sitzungsberichte der physikal.-medizin. Gesellschaft., Dec. 28, 1895, p. 132.

¹⁷ Lenard, P. Grosse Naturforscher. J. F. Lehmanns Verlag, München, 1930, p. 288.

¹⁸ Tomaschek, Grimsehl. Lehrbuch der Physik. Teubner, Leipzig, Vol. II, Part I, p. 311, 1936.

¹⁹ Lenard, P. Deutsche Physik. Lehmanns, München, 1936.

* The Philipp Lenard Institute. (The library contained many volumes by both Jewish and Japanese physicists.)

²⁰ Lenard, P. Wissenschaftliche Abhandlungen, Vol. III, p. 1

querel's discovery (radioactivity, 1896), radium by Curies and continually many additional advances." Thus to make it appear that anything further developing in the field of atomic research was directly traceable to his cathode-ray studies. Anyone will agree that such a position is untenable as "every scientist and his work is but the child of his scientific forefathers."²¹

We could hope that Röntgen had written more about the actual mode of the discovery, but he was an extreme introvert and deep thinker and not readily communicative.²² Once, when at the behest of Dr. Harms, Mrs. Boveri queried Röntgen about the discovery, he became angry and said, "One would almost have to excuse himself if he discovered something." He had plainly stated in his first communication how he made the discovery and had told

assistants and associates that he had first worked with Hittorf and Crookes tubes. He considered that was enough.

And there we leave it—with the genius of Röntgen clearly established as the responsible factor in the discovery of x-rays. The contentions, excuses and barbs of Lenard have not been able to shake Röntgen from his secure position as one of the greatest scientists of all time.

Pinewood Farm
Warrendale, Penna.

The author expresses his appreciation to Dr. Otto Glasser for his help with translations and editorial assistance, and to Misses Gertrud Weinberg and Anna Michel of Kassel, Germany, Sgt. Bernard Berger and S/Sgt. Joel Schwab, 115th Gen. Hosp., for invaluable help as translators and interpreters. Thanks are likewise due Prof. Dr. Harms, Director of the Physical Institute University of Würzburg and his assistants of the Physics faculty for their kindness in furnishing much of the material for this article.

²¹ Thompson, Sylvanus P. The Röntgen Society, London, Nov. 5, 1897, quoted in "The Physical Foundations of Radiology" edited by Otto Glasser. Also see Glasser, Otto, "The genealogy of the roentgen rays." AM. J. ROENTGENOL. & RAD. THERAPY, 1933, 30, 180, 349.

²² Glasser, Otto. Strange repercussions of Röntgen's discovery of the x-rays. *Radiology*, 1945, 45, 425-427.



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Twenty-ninth Annual Meeting: To be announced.

E D I T O R I A L S

THE ANNUAL MEETING

THE Forty-seventh Annual Meeting of the American Roentgen Ray Society will be held at the Netherland Plaza Hotel, Cincinnati, Ohio, September 17 to 20, 1946. This will be the first time the scientific sessions of the Society have been held since the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America in Chicago in September, 1944.

The choice of Cincinnati as a meeting place is an excellent one as the Netherland Plaza offers splendid facilities for both the Scientific and Commercial Exhibits as well as ample rooms for the Scientific programs and the Instruction Courses. Those who were privileged to attend the meeting of the Society in Cincinnati in 1941 will recall with a great deal of pleasure that meeting, probably one of the best the Society has ever had.

Unfortunately, we will miss some of the familiar faces that were present at that meeting. Among these is our own past president, Dr. William M. Doughty, Dr. Kennon Dunham and Dr. E. R. Bader, all former residents of Cincinnati, who have died since the meeting in 1941.

The President Elect, Dr. Raymond C. Beeler, and his Program Committee have arranged an excellent scientific program which should make a special appeal to all members of the Society and it is expected that in the return of the world to an appreciable state of normality there will be a very large attendance at the forthcoming meeting.

The Instruction Courses which have hitherto been an important feature of the annual meeting will again be offered and these courses are under the direction and leadership of Dr. B. R. Kirklin who has so

ably conducted them in the past. The current issue of the JOURNAL carries not only the Preliminary Program but also the schedule of the Instruction Courses. Since the number who can attend these courses is limited, it is urged that those who anticipate taking these courses fill out the order blank at once.

The Chairman of the Scientific Exhibits, Dr. S. W. Donaldson, and his committee have arranged an excellent exhibit, many of them amplifying and extending the papers to be given in the scientific program.

The Commercial Exhibits, which are always of interest, will again be a part of the meeting. They will be considerably enlarged both in numbers and in the quality of the exhibits.

One of the highlights of the program will be the annual Caldwell Lecture which this year will be given by Dr. A. C. Ivy, Professor of Physiology of Northwestern University Medical School, Chicago, Illinois. The title of this lecture is "Motor Dysfunction of the Biliary Tract: An Analytical and Critical Consideration." Dr. Ivy's pre-eminence in his chosen field is acknowledged and thus this year's Caldwell Lecture on such an important subject is anticipated with a great deal of pleasure.

The social functions which are always a pleasant feature of the annual meetings, particularly those which have been held in Cincinnati, will offer periods of relaxation in the midst of the scientific activities.

All in all, this forthcoming meeting should attract great numbers of radiologists, particularly those who have been in the Armed Forces. In view of this fact, it is urged that all who anticipate attending the meeting make their reservations with the hotel at the earliest possible moment.



ROLLIN HOWARD STEVENS 1868-1946

ONE of the American pioneers and stalwarts in radiology and cancer therapy, Dr. Rollin Howard Stevens, died on May 17, 1946, of acute leukemia, following a comparatively short illness.

Dr. Stevens was born in Blenheim, Ontario, January 7, 1868. By the time he was

eighteen years old he had matriculated at the University of Toronto in preparation for a Bachelor's Degree. In 1886 he entered the Homeopathic Medical College of the University of Michigan from which he graduated in 1889. Following his graduation, Dr. Stevens was fully determined to

enter private practice in one of the Canadian communities, but upon learning of a competitive examination to be given for interns at Grace Hospital, Detroit, he offered himself as a candidate and was accepted. His internship at Grace Hospital was completed in 1891. Then followed some post-graduate work at the recently established Leland Stanford Jr. University. He returned to Detroit and became associated again with Grace Hospital and was appointed to the clinical staff. He served successively in this hospital as pathologist, surgeon and gynecologist from 1892 to 1904.

However, his interests were not confined to the usual and accepted medical fields alone. Early in his career he became interested in the use of light therapy in the treatment of tuberculosis. This prompted him to study at the Finsen Institute in Copenhagen where he became particularly interested in dermatological lesions which were improved by the use of radiant energy. Consequently he visited and studied in the leading dermatological clinics in Europe. Upon his return to Detroit he introduced the first Finsen light into American medicine, and in 1904 he was officially transferred to the Dermatological Staff of Grace Hospital and became a lecturer on dermatology to the Homeopathic Medical School of the University of Michigan.

It was fortunate that this period of time coincided with Röntgen's discovery and early use of x-rays, as it introduced to Dr. Stevens another vehicle of therapy. And this was the stimulus for him to establish a Department of Radiology and Dermatology in Grace Hospital, which, incidentally, was one of the first radiological departments in Michigan.

He recognized early in his dermatological investigation the curative effects of light energy in treating malignant lesions of the skin and the similarity of the effects of roentgen rays and radium. This prompted him to secure radium from the Curie Institute in Paris as early as 1903, making him the first man west of New York City to

employ radium as a therapeutic agent in the treatment of malignant disease.

He was still a young research worker when he realized that, in order to advance scientifically, it was necessary to have a singleness of purpose and he set his course toward the promotion of radiation therapy in the treatment of malignancies. This remained his life's work and at the time of his death he was an authority in the field of cancer therapy and he was the acknowledged founder of the Detroit Institute of Cancer Research.

Throughout his professional career he endeavored to advance medicine only medically, and he took a very active part in the leading local and national medical societies. He was a faithful attendant at all medical meetings and appeared frequently on their scientific programs with original contributions. In recognition of these activities he was made President of the American College of Radiology, the Radiological Society of North America, the American Radium Society, the Michigan Society of Social Hygiene, the Detroit Roentgen Ray and Radium Society and the Detroit Dermatological Society.

But his efforts were not entirely scientifically directed. He also found time for benevolent and extra-curricular activities, and the many years he devoted to the Boys' Republic—a self-governing home for delinquent boys in Michigan—exemplified his interest in the social welfare of others, and especially the youth.

For his mental and physical relaxation he would make periodic field excursions in search of mushrooms and expeditions after rare mollusks. Not only was he, for years, the President of the Detroit Mycological Society, but he had a national reputation as a mycologist. One variety of mushroom he discovered has been officially named for him—*Helvella stevensii*. Frequently the very early morning hours would find him busy in his garden, tenderly giving the flowers he so dearly loved the attention they required to blossom into his "Garden Beautiful."

In his death, science has lost an enthusi-

astic exponent of cancer therapy and research, but the result of his efforts in establishing radiology as a specialty will live on.

Humanity has lost a friend, but his pas-

sing cannot stay the influence of his manifold interests and activities.

Such *was* and *is* Doctor Rollin Howard Stevens!

CLYDE K. HASLEY



SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Sept. 17-20, 1946.

AMERICAN COLLEGE OF RADIOLOGY

Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting, 1947: To be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting, 1947: To be announced.

AMERICAN RADIUM SOCIETY

Secretary, Dr. E. H. Skinner, 1532 Professional Bldg., Kansas City, Mo. Annual meeting, 1947: To be announced.

ARKANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Palmer House, Chicago, Ill., Dec. 1-6, 1946.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

Secretary, Dr. Max Clinan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

RADIOLOGICAL SECTION, LOS ANGELES CO. MED. ASSN.

Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. Roy G. Giles, Temple, Texas.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. Carroll C. Dundon, 11311 Shaker Blvd., Cleveland, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB

Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DENVER RADIOLOGICAL CLUB

Secretary, Dr. A. Page Jackson, Jr., 1612 Tremont Place, Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Dell, Jr., 333 W. Main St., S., Gainesville, Fla. Meetings in May and November.

GEORGIA RADIOLOGICAL SOCIETY

Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

RADIOLOGICAL SOCIETY OF KANSAS CITY

Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets annually second Sunday in May.

IOWA X-RAY CLUB

Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KENTUCKY RADIOLOGICAL SOCIETY

Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY

Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

LOUISIANA RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

NEBRASKA RADIOLOGICAL SOCIETY

Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Neb. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY

Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

RADIOLOGICAL SOCIETY OF NEW JERSEY

Secretary, Dr. W. H. Seward, Orange Memorial Hospital, Orange, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY

Secretary, Dr. Major Fleming, Rocky Mount, N. C.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

NORTH DAKOTA RADIOLOGICAL SOCIETY

Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY

Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

OHIO RADIOLOGICAL SOCIETY

Secretary, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

ORLEANS PARISH RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC ROENTGEN SOCIETY

Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. C. L. Stewart, Jefferson Hospital. Meets first Thursday of each month, October to May, at 8:00 p.m., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY

Secretary, Dr. L. M. J. Freedman, 4800 Friendship Ave. Meets 6:30 p.m. at The Ruskin on second Wednesday, each month, October to May inclusive.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 p.m. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Secretary Dr. A. M. Popma, 220 N. First St., Boise, Idaho. Mid-Summer Conference, August 8, 9, 10, 1946, at Shirley Savoy Hotel, Denver, Colorado.

ST. LOUIS SOCIETY OF RADIOLOGISTS

Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY

Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly on first Wednesday at dinner.

SAN FRANCISCO RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph Levitin, 516 Sutter St., San Francisco 2, Calif. Meets monthly on the third Thursday at 7:45 p.m., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

SHREVEPORT RADIOLOGICAL CLUB

Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 p.m., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 p.m. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 p.m., Room 301, Service Memorial Institute.

VIRGINIA RADIOLOGICAL SOCIETY

Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO

Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA

General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE ROENTGEN SOCIETY

Medical Members' meeting held monthly on third Friday at 2:30 p.m. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 4:45 p.m. at the Royal Society of Medicine, 1 Wimpole St., London.

FACULTY OF RADIOLOGISTS

Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

CANADIAN ASSOCIATION OF RADIOLOGISTS

Secretary, Dr. J. W. McKay, 1620 Cedar Ave., Montreal.

SOCIÉTÉ CANADIENNE-FRANCAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES

Secretary, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

SOUTH AMERICA

SOCIEDAD ARGENTINA DE RADIOLOGIA

Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDAD PERUANA DE RADIOLOGIA

Secretary, Dr. Victor Giannoni, Apartado, 2306, Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

CONTINENTAL EUROPE

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

Secretary, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

Secretary for French language, Dr. Babaianz, Geneva. *Secretary* for German language, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, Leningrad: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY

Secretaries, Drs. L. L. Holst, A. W. Szamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 p.m.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

PRELIMINARY PROGRAM

FORTY-SEVENTH ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

The Forty-seventh Annual Meeting of the American Roentgen Ray Society will be held at the Netherland Plaza Hotel, Cincinnati, Ohio, on September 17, 18, 19 and 20, 1946.

The Executive Council will meet at noon on Sunday, September 15.

The annual Golf Tournament for the Willis F. Manges Trophy will be held on Monday, September 16, at the Hyde Park Golf and Country Club.

The Caldwell Lecture will be given on Tuesday evening, September 18, and the Annual Banquet will be held on Thursday evening, September 19.

The Instruction Courses will be given at 8:00 A.M. and 9:30 A.M. each day of the meeting and elsewhere in this issue will be found the detailed plan of the courses.

The scientific program has been arranged as follows:

Tuesday, September 17, 1946

8:00 A.M. Instruction Courses.

11:00 A.M. Call to Order, Forty-seventh Annual Meeting. Ross Golden, M.D., President.

Installation of the President-Elect, Raymond C. Beeler, M.D., Indianapolis, Ind., by President Golden and the Chairman of the Executive Council, Charles M. Richards, M.D., San Jose, Calif.

Inaugural Address: "Radiology in the Atomic Age." President Raymond C. Beeler, M.D.

11:20 A.M.

Paper
No.

1. The Roentgen Diagnosis of Diaphragmatic Hernia. B. R. Kirklin, M.D., and John R. Hodgson, M.D. (by invitation) Rochester, Minn.

2:00 P.M.

2. The Crater in Uncomplicated Duodenal Ulcer—Its Significance in Diagnosis and Treatment. Frederic C. Templeton, M.D., Seattle, Wash.

3. Post-bulbar Ulcers of the Duodenum. Robert P. Ball, M.D., and Allan Seagel, M.D. (by invitation), New York, N. Y.

4. Psychosomatic Relationships in Duodenal Ulcer. Herbert S. Gaskill, M.D. (by invitation), Philadelphia, Pa.

Discussion of papers 2-4 to be opened by Joseph C. Bell, M.D., Louisville, Ky., and B. R. Kirklin, M.D., Rochester, Minn.

5. Results of Treatment of Carcinoma of the Cervix in General, and by the Intra-vaginal Method in Particular. Ralph M. Caulk, M.D. (by invitation), and Edwin A. Merritt, M.D.,* Washington, D. C.

Discussion to be opened by Arthur W. Erskine, M.D., Cedar Rapids, Iowa.

6. Analysis of Technical Factors Involved in Treatment of Carcinoma of the Cervix Uteri. G. E. Richards, M.D., Toronto, Canada.

Discussion to be opened by Charles L. Martin, M.D., Dallas, Texas.

7. Roentgen Therapy in Uterine Fibromyomata without Ovarian Sterilization. George E. Pfahler, M.D., Philadelphia, Pa.

Discussion to be opened by Edwin C. Ernst, M.D., St. Louis, Mo.

4:30 P.M. Executive Business Session of the Society.

Tuesday Evening, September 17, 1946

Eight-Thirty O'Clock

The Caldwell Lecture

A. C. Ivy, Ph.D., M.D.

Nathan Smith Davis Professor of Physiology, Northwestern University Medical School, Chicago, Illinois

"Motor Dysfunction of the Biliary Tract: An Analytical and Critical Consideration"

Introduction—James T. Case, M.D., Chicago, Illinois

Wednesday, September 18, 1946

8:00 A.M. Instruction Courses.

* Deceased.

11:00 A.M.

8. Bronchography in Children. Eduardo Rivero, M.D. (by invitation), Havana, Cuba.

Discussion to be opened by Ross Golden, M.D., New York, N. Y.

9. Body Section Roentgenography in Carcinoma of the Lung. Leo G. Rigler, M.D., Minneapolis, Minn., and T. B. Werner, M.D. (by invitation).

Discussion to be opened by Sherwood Moore, M.D., St. Louis, Mo.

2:00 P.M.

10. Angiography in the Diagnosis of Intracranial Lesions. Philip J. Hodes, M.D., C. R. Perryman, M.D., and R. H. Chamberlain, M.D., Philadelphia, Pa.
Discussion by Fred J. Hodges, M.D., Ann Arbor, Mich.

11. Angiocardiography in Mediastinal Tumors. Marcy L. Sussman, M.D., New York, N. Y.

Discussion by Merrill C. Sosman, M.D., Boston, Mass.

12. Abdominal Aortography, Paul C. Swenson, M.D., and Fred B. Wagner, M.D. (by invitation), Philadelphia, Pa.

Discussion by P. L. Fariñas, Havana, Cuba.

13. Abdominal Venography. Pedro L. Fariñas, M.D. (by invitation), Havana, Cuba.

Discussion by Leo G. Rigler, M.D., Minneapolis, Minn.

14. Problems in Venography, Edgar G. Baker, M.D., Youngstown, Ohio.

15. Roentgenologic Findings in Myasthenia Gravis Associated with Thymic Tumor. C. Allen Good, M.D., Rochester, Minn.

Discussion to be opened by Aubrey O. Hampton, M.D., Washington, D. C.

16. Benign Histoplasmosis and Pulmonary Calcification. Amos Christie, M.D. (by invitation), and J. C. Peterson, M.D. (by invitation), Nashville, Tenn.

Discussion to be opened by L. R. Sante, M.D., St. Louis, Mo.

17. The Comparative Efficiency of Mass Roentgenography Methods. Herman E. Hilleboe, M.D. (by invitation), Washington, D. C., and Russell H. Morgan, M.D. (by invitation), Chicago, Ill.

Discussion to be opened by W. E. Chamberlain, M.D., Philadelphia, Pa.

18. Benign Pneumoconiosis Due to Metal Fumes and Dusts. O. A. Sander, M. D. (by invitation), Milwaukee, Wis.

Discussion to be opened by Hollis E. Potter, M.D., Chicago, Ill.

Thursday, September 19, 1946

8:00 A.M. Instruction Courses.

11:00 A.M.

19. The Roentgen Diagnosis of Congenital Cardiovascular Abnormalities Amenable to Surgery. Edward B. D. Neuhauser, M.D. (by invitation), Boston, Mass.

20. The Physiopathology of Congenital Heart Disease. Richard J. Bing, M.D. (by invitation), Baltimore, Md.

Discussion of papers 19 and 20 to be opened by Merrill C. Sosman, M.D., Boston, Mass.

2:00 P.M.

21. Radioactive Sodium as a Tool in Medical Research. Edith H. Quimby, Sc.D., New York, N. Y.

22. Principles of Tissue Dosage in Radioisotope Therapy. Robley D. Evans, Ph.D. (by invitation), Boston, Mass.

23. Radioactive Phosphorus as a Therapeutic Agent. Edward H. Reinhard, M.D. (by invitation), St. Louis, Mo.

24. Medical Uses of Radioactive Iodine. Earl Miller, M.D. (by invitation), San Francisco, Calif.

25. Comparative Therapeutic Effects of Radioactive and Chemical Agents in Neoplastic Diseases of the Hemopoietic System. A. M. Brues, M.D. (by invitation), and L. O. Jacobson, M.D. (by invitation), Chicago, Ill.

Discussion by G. Failla, Sc.D., New York, N. Y., R. E. Zirkle, Ph.D., Chicago, Ill., and L. O. Jacobson, M.D. Chicago, Ill.

26. The Standardization of Roentgen-Ray Tubes and Cables. Russell H. Morgan, M.D. (by invitation), Chicago, Ill.

Discussion to be opened by Paul C. Hodges, M.D., Chicago, Ill.

4:30 P.M. Executive Business Session of the Society.

Thursday Evening, September 19, 1946

Seven-Thirty O'Clock

Annual Banquet

Friday, September 20, 1946

8:00 A.M. Instruction Courses.

11:00 A.M.

27. Pulmonary Tubercles or Nodules. Lewis Gregory Cole, M.D., White Plains, N.Y.

Discussion to be opened by E. P. Pendergrass, M.D., Philadelphia, Pa.

28. Pulmonary Disease Due to Friedländer Bacillus. Carleton B. Peirce, M.D., Montreal, Canada, and Dso Li-Liang, M.D. (by invitation).

Discussion to be opened by M. A. Blankenhorn, M.D., Cincinnati, Ohio.

2:00 P.M.

29. Preliminary Studies on the Biological Effects of 20,000,000 Volt Radiation. Jack T. Wilson, Ph.D., Milwaukee, Wis.

30. The Therapeutic Application of Induction Electron Accelerators. E. E. Charlton, Ph. D., Schenectady, N. Y.
Discussion of papers 29 and 30 to be

opened by Henry Quastler, M.D., Urbana, Ill.

31. Comparative Value of Deep and Super-voltage Roentgen Therapy. T. Leucutia, M.D., Detroit, Mich.

Discussion to be opened by U. V. Portmann, M.D., Cleveland, Ohio.

32. Supervoltage Radiation. George W. Holmes, M.D., and Milford D. Schulz, M.D. (by invitation), Boston, Mass.

Discussion to be opened by David Steel, M.D., Cleveland, Ohio.

33. The Use of High Voltage Roentgen Therapy in the Treatment of Amenorrhea and Sterility in Women. Ira I. Kaplan, M.D., New York, N. Y.

Discussion to be opened by William Harris, M.D., New York, N. Y.

34. Fibrous Dysplasia of Bone. Franklin B. Bogart, M.D., Chattanooga, Tenn., and Allison E. Imler, M.D. (by invitation), Birmingham, Ala.

Discussion to be opened by Ralph S. Bromer, M.D., Bryn Mawr, Pa.

35. Congenital Malformations Induced in Rats by Roentgen Rays; Skeletal Changes in the Offspring Following a Single Irradiation of the Mother. Josef Warkany, M.D. (by invitation), and Elizabeth Schraffenberger, M.D. (by invitation), Cincinnati, Ohio.



AMERICAN ROENTGEN RAY SOCIETY

SECTION ON INSTRUCTION

B. R. KIRKLIN, M.D., *Director**Abstracts of Courses Offered*

Forty-seventh Annual Meeting

Netherland Plaza Hotel, Cincinnati, Ohio

September 17-20, 1946

President-Elect Beeler, with the approval of the Executive Council, has directed that the Section on Instruction be continued for the 1946 annual meeting. He has arranged his program so that the instruction courses will be given between the hours of 8:00 A.M. and 10:45 A.M. on Tuesday, Wednesday and Thursday, and 8:00 A.M. and 9:15 A.M. on Friday. Nothing else will be scheduled during these hours, thus allowing everyone at the meeting to attend the Instruction Courses each morning.

This Section presents for 1946:

1. Four special Sequential Courses, lettered "A" to "D," with a faculty of four instructors and covering eleven periods.
2. Eight single-period courses on Radiation Physics, with a faculty of eight instructors and covering eight periods.
3. Thirteen single-period courses on Therapeutic Radiology, with a faculty of thirteen instructors and covering sixteen periods.
4. Twenty-nine single-period courses on Diagnostic Roentgenology, with a faculty of thirty-one instructors and covering thirty-five periods.

GENERAL INFORMATION

Conference Periods

Tuesday, Wednesday, Thursday and
Friday mornings

First period.....8:00 to 9:15
Second period.....9:30 to 10:45

Location

All courses will be given in parlors A to J located on the fourth floor of the Netherland Plaza Hotel. Full information may be

secured at the general registration desk which will be located nearby.

Code

The instruction periods will be designated with the following code:

T-1 Tuesday, first period.....8:00 to 9:15
T-2 Tuesday, second period...9:30 to 10:45
W-1 Wednesday, first period...8:00 to 9:15
W-2 Wednesday, second period.9:30 to 10:45
Th-1 Thursday, first period.....8:00 to 9:15
Th-2 Thursday, second period..9:30 to 10:45
F-1 Friday, first period.....8:00 to 9:15

(Familiarity with this code will
avoid much confusion)

How To Secure Tickets for Instruction Courses

Admission to the Instruction Courses will be by ticket only.

Following the abstracts of the courses will be found a general order sheet. First, second and third choices for each period should be carefully selected as the number attending each course given during these periods will be limited to from thirty to forty persons. If directions as given on the order sheet are followed explicitly, errors in completing reservations will be minimized.

If you are requesting registration in one or more of the Special Sequential (continuous) Courses, please indicate for each period your second and third choices of individual single-period courses as substitutes—to avoid disappointment should the Sequential Courses be filled when your order is received.

It is possible for one to attend only seven periods of instruction, so the condensed

schedule should be noted carefully in arranging individual orders for tickets.

Reservations will be made in the order of receipt of the order forms. Those who are not members of the American Roentgen Ray Society will be charged a nominal fee of \$1.00 per period, or a maximum fee of \$5.00 for five or more periods. Full time graduate students in Radiology will be admitted without fee.

Previous to September 7, send orders to Rochester, Minnesota; after September 7, send orders directly to Dr. B. R. Kirklin, Netherland Plaza Hotel, Cincinnati, Ohio.

If the courses are not filled by the time of the meeting, tickets will be available at the registration desk, located on the Fourth Floor, on Sunday, September 15, and thereafter during the meeting.

Holders of Tickets

Those who do not have a proper ticket for the assigned course will not be permitted to enter the room. Pages will be assigned to each conference room to collect tickets.

Duplications and Repeats

Due to the anticipated heavy registration a few of the single-period courses will be repeated and others will be duplicated by two or more instructors.

SEQUENTIAL COURSES

COURSE: A (2 periods)

Room: A Periods: Th-2; F-1

S. W. DONALDSON, M.D., Ann Arbor, Michigan

Medical Jurisprudence as Applied to Radiology

This course will take into consideration the relationship between physician and patient and the various contracts entered into between them. Malpractice will be defined and consideration given to all acts of the radiologist that may be subject to allegation of negligence or other grounds for suit. The Law of Agency will be discussed and its application to the radiologist in regard to his liability for the acts of those employed by him. Pointers will

be given about malpractice defense and prophylaxis. The legal requirements for the introduction of films as evidence in courts of law will also be taken up as well as that for physician's records and hospital records. There will be discussion of privileged communications as related to roentgen examinations, the admissibility of evidence, expert testimony, expert witness fees, and court room procedure for the witness.

COURSE: B (3 periods)

Room: G Periods: T-1; W-1; Th-2

ROSS GOLDEN, M.D., New York City

Roentgenology of the Small Intestine

Tuesday

- Technique
- Normal small intestine
 - Anatomy
 - Physiology
- Indications for small intestine study
- Diverticula
- Disturbances in physiology
 - Emotion
 - Vagotonia
 - Multiple peritoneal adhesions
- Developmental anomalies
 - Internal hernia
 - Congenital diaphragm
- Effect of disease of the mesentery
 - Localized
 - Generalized
 - Lymphoblastoma
 - Sclerosing mesenteritis

Wednesday

- The "Deficiency Pattern"
 - Vitamin deficiency states
 - Hypoproteinemia
 - Biliary tract disease
 - Pancreatic disease
- Allergy
- Inflammations
 - Tuberculous
 - Non-tuberculous
 - Sclerosing regional enteritis
 - Non-sclerosing regional enteritis

Thursday

- Neoplasms
 - Benign
 - Malignant
 - Carcinoma and carcinoid
- Lymphosarcoma
 - Localized
 - Diffuse
- Benign ulcer

Ileus

- Diagnosis by 3 position abdominal films
 - Paralytic
 - Mechanical
 - Mesenteric vascular occlusion
- The Miller-Abbott tube
 - Technique of insertion
 - Deflation
 - Injection of barium for
 1. Localization
 2. Demonstration of type of obstruction
 - Complications

COURSE: C
(4 periods)

Room: H Periods: T-1; W-1; Th-1; F-1

W. WALTER WASSON, M.D., Denver, Colo.

The Anatomy, Physiology, and Mechanics of the Chest as a Basis for the Study of Chest Diseases and Their Classification

This is an effort to portray the chest so that the clinician or radiologist can actually visualize the thoracic viscera and their diseases. A child begins life with certain anatomical structures which change with the years both as a result of physiological processes and disease. The pathological reactions which the clinician or the radiologist is called upon to diagnose are definitely influenced by the particular physiology and mechanics of this anatomy. Accordingly, any classification of chest disease must be based upon the pathological reactions of disease as influenced by anatomy and of the physiology and mechanics of this anatomy.

The presentation will be made in the following sections:

- | | |
|--|--------------|
| 1. Anatomy of the Lungs. | Period: T-1 |
| 2. Physiology and Mechanics of the Chest and Particularly of the Lungs. | Period: W-1 |
| 3. The Classification of Diseases of the Lungs. | Period: Th-1 |
| 4. Illustrations of the Different Diseases of the Lungs and their Diagnosis. | Period: F-1 |

COURSE: D
(2 periods)

Room: A Periods: Th-2; F-1

FEDERICO GARCIA CAPURRO, M.D.,
Montevideo, Uruguay

Topographical Roentgenological Diagnosis of the Tumors of the Abdomen

This course will take into consideration the fundamental principles of the topographical diagnosis of the tumors of the abdomen, including those of the gastrointestinal tract.

Consideration of the Fundamentals of Topographical Diagnosis

Period: Th-2

1. *Peritoneal embryogenesis* and its influence on the anatomical displacements produced by the tumoral expansion.
2. *Roentgenological concepts of the topographical anatomy of the abdomen.* Outline of the three anatomical systems of viscera. The fixed points of the anatomy or "landmarks" of the topographical diagnosis.
3. *The physical equilibrium of the abdomen* and its relation to the displacements produced by the tumors.
4. *Technique of roentgenological procedure.* The dynamic roentgenology.

The Topographical Syndromes.

Period: F-1

The different tumors of the regions into which the abdomen is divided for practical purposes of clinical examination will be considered from the viewpoint of establishing the differential diagnosis.

The fundamental principles involved in this type of diagnosis will be illustrated with lantern slides.

SINGLE PERIOD COURSES

RADIATION PHYSICS

COURSE: 101

Room: E

Period: T-1

CARL B. BRAESTRUP, Ph.D., New York City

Common Causes of Radiation Hazards in Roentgenology

Radiation injuries are caused mainly by faulty equipment, inadequate structural shielding or improper operating procedures.

Equipment. Most improvements in roentgen-ray equipment have been in the direction of greater safety. Thus the protective tube housing practically limits the radiation to the useful beam. On the other hand, the important progress made in roentgen-ray tube design has so greatly increased the available dosage rate that permanent skin injuries may be produced in a few seconds. It is important, therefore, that roentgen therapy equipment be provided with accurate means for the control of the dose.

The protection afforded the patient, the radiologist and attendants during fluoroscopy depends to a large extent upon the construction of the fluoroscope. The use of large target-panel distances and adequate filtration reduces materially the exposure to the patient. The dose received by the fluoroscopist can be cut down considerably by proper diaphragming

of the useful beam and ample shielding against scattered radiation.

Structural Shielding. The use of protective equipment has often produced a false sense of security especially where the equipment is represented as "ray-proof." Obviously barriers must be provided against the useful beam and resultant scattered radiation. Radiation injuries due to inadequate structural shielding seldom manifest themselves for years when permanent damage has already been done. No roentgen-ray installations, therefore, should be considered safe until so established by ionization measurements or similar tests.

Operating Procedures. Most radiation injuries can be ascribed to the failure of the human element, caused either by carelessness or lack of understanding of the protection problem. Fracture setting under fluoroscopy is probably the greatest cause of radiation injuries in diagnostic roentgenology. The greatest radiation hazard in therapy is the omission of the proper filter. Another frequent cause of overexposure of the patient is the incorrect use of ionization instruments.

Actual cases of radiation hazards will be presented to demonstrate that no roentgen-ray installation is safe unless properly used.

COURSE: 102

Room: E

Period: W-1

G. FAILLA, Ph.D., New York City

Dosage Problems in the Use of Radioactive Isotopes

Radioactive isotopes. Availability and possible uses as tracers and for therapy.

Discussion of physical characteristics (activity, half-life, type and energy of radiation).

Tissue dosage determinations: (1) when used in "applicators" as in the case of radium or radon; (2) when introduced into the body as chemical compounds.

Influence of rate of decay, elimination, local concentration.

Dangers in the use of radioactive isotopes internally administered.

Protection of personnel.

Dosage data and charts will be presented.

COURSE: 103

Room: E

Period: W-2

OTTO GLASSER Ph.D., Cleveland, Ohio

Atomic Energy in Radiology

A short historical account of the development of both electronic energy and nuclear energy will be presented, starting with the discovery of the roent-

gen ray in 1895. From the wealth of information on the structure of the atom and its inherent energy those facts and problems will be selected which are of special interest to the radiologist. Such facts comprise the production of roentgen rays at super-voltages, production of fast electron streams, chipping and smashing of atoms, production of radioactive tracers and fission particles. Problems comprise application of short wave roentgen rays and fast electrons in biological work, use of radioactive isotopes for diagnostic and therapeutic purposes and practical aspects of energies released by fission.

COURSE: 104

Room: E

Period: T-2

GEORGE C. HENNY, M.Sc., M.D.,
Philadelphia, Pa.

Roentgen Film Characteristics and the Practical Calibration of Roentgenographic Apparatus and Processing Solutions

The characteristics of the roentgen film emulsion (together with intensifying screens if they are used), in which the roentgenologist is mainly concerned, are the "speed" and the "contrast." These characteristics are of great importance.

The "speed" determines the degree of darkening of the processed film, after standard development, for a given roentgenographic exposure and a particular anatomic part.

The "contrast," under the same conditions, determines the degree to which tissue density-differences and thickness-differences of the anatomic part will be recorded on the roentgenogram.

For uniformity of results the roentgenographic apparatus and processing solutions should be calibrated at regular intervals. Fairly simple methods of calibration, which are accurate enough for the purpose, are described and may be employed in the roentgen department without great outlay of time or money. When properly employed the roentgenograms of a given patient show uniform density from one examination to the next and the detail of the anatomic parts being studied is, as far as the film emulsion is concerned, brought out to the greatest degree.

COURSE: 105

Room: E

Period: Th-2

EDITH H. QUIMBY, Sc.D., New York City

Dosage Calculations in Radium Therapy

The development of dosage units for radium therapy will be traced briefly. Various charts and tables for determination of dosage in roentgens will be presented. Most of the period will be devoted to working out practical problems.

COURSE: 106

Room: E

Period: Th-1

LAURISTON S. TAYLOR, Ph.D.,
Washington, D. C.

Ionization Chambers and Their Uses

A non-technical discussion will be given on the uses and limitations of various types of ionization chambers. The clinical applications of the thimble chamber will be discussed pointing out the limitations in its use, the methods of making corrections in measurements, and the general factors which enter into the measurements. The problem of measuring very soft roentgen rays by means of special ionization chambers will also be discussed. The measurement of megavolt radiation and gamma rays together with the instrumental limitations will be developed together with the means of applying corrections to the clinical measurements that may be made.

COURSE: 107

Room: E

Period: F-1

J. L. WEATHERWAX, M.S., Philadelphia, Pa.

Dosage Calculations in Roentgen Therapy

1. Comparison of roentgens measured in air, on the skin and at a depth in a phantom or tissue.
2. Factors influencing backscatter to skin portals.
3. Factors influencing penetration into the tissue.
4. Depth dose charts and a study of the intensity tables as found in "Physical Foundations of Radiology."
5. Study of contact therapy as to quality, penetration and radiation distribution.
6. A short discussion of supervoltage radiation therapy. (If time permits.)
7. Methods of estimating tumor dose in tissue roentgens.

COURSE: 108

Room: F

Period: T-2

MARVIN M. D. WILLIAMS, Ph.D.,
Rochester, Minnesota

Roentgen-Ray Circuits and Apparatus

The effect of voltage and current and their wave forms on the quality and dosage rate of radiation will be briefly reviewed. The common circuits used in roentgenographic and therapy machines will be illustrated, and the voltage and current wave forms produced by each will be shown on an oscillograph. The effect on voltage wave form produced by certain changes in equipment will be shown and the resultant effect on radiation output discussed.

THERAPEUTIC RADIOLOGY

COURSE 201

Room: J

Period: Th-1

E. C. ERNST, M.D., St. Louis, Mo.

Practical Concepts of Radiation Treatment of Carcinoma of the Cervix Uteri

SYNOPSIS

- (a) *Clinical Management and Preliminary Considerations*
- (b) *Indications for Roentgen Therapy:*
 1. Indirect irradiation of the pelvis.
 2. Direct (intravaginal) roentgen-ray applications.
- (c) *Essential Tumor Dose Measurement Factors*
- (d) *Indications for Radium Therapy:*
 1. Evaluation of the various methods and the intracervical applicators.
 2. Essential minimum requirements for obtaining the ideal uniform distribution of radium radiations.
- (e) *Prognostic Factors:*
 1. Tumor grading.
 2. Stage of the disease.
 3. Initial response to preliminary roentgen irradiation.
- (f) *Final Discussion Period:*
 1. Case presentations.
 2. Questions (15 minutes).

ABSTRACT

The practical irradiation management of carcinoma of the cervix will be discussed both from the standpoint of the institutional tumor clinic and the private office procedure. Although realizing that the radiation treatment standards continue to remain somewhat in a state of flux and that individualization in the application of roentgen rays and radium is a most essential consideration, nevertheless certain fundamental concepts in our routine procedures are most helpful in the management of cancer of the cervix. These and many other practical therapeutic considerations, including external roentgen therapy, intracavity radium and roentgen methods of treatment and the dosage measurement problems, will be discussed and illustrated.

COURSE: 202

Room: F

Period: T-1

ROBERT E. FRICKE MD.,
Rochester, Minnesota

Radium Therapy for Nonmalignant Conditions

While the more urgent control of cancer occupies most of the energies of the physician employing radium, a surprisingly large number of nonmalignant conditions have been found to respond readily to

radium therapy. These nonmalignant diseases form quite a heterogeneous group and are very interesting; some are very widespread and others are quite rare. During the past several years, the number of patients treated with radium at the Mayo Clinic for benign conditions has averaged 45 to 48 per cent of the total. These patients were treated for nonmalignant disorders in the realms of otolaryngology, gynecology, pediatrics, urology, dermatology, ophthalmology and surgery.

Discussion of these interesting conditions will be illustrated by slides and some of the radium applicators will be exhibited when discussing technique.

COURSE: 203

Room: D

Periods: Th-1; F-1

MILTON FRIEDMAN, M.D.,
New York City

Supervoltage Roentgen Therapy

The increasing use of supervoltage roentgen therapy necessitates reorientation of certain concepts in radiotherapy. Since skin damage is no longer a major obstacle, the principle of "giving as much as the skin can stand" is no longer a guide. It now becomes necessary to ascertain the specific lethal tumor dose for the lesion being irradiated, and the tolerance dose of the adjacent normal structures, which varies considerably for different organs.

Physical characteristics of a beam of supervoltage radiation will be discussed from the standpoint of clinical applications.

The methods of ascertaining the tumor dose of the lesion under treatment will be discussed, including principles of interpretation of quantitative cytologic destruction in biopsies taken during treatment.

Finally specific tumors will be discussed from the standpoint of (1) radioincurable lesions which are brought within range of radiocurability by supervoltage roentgen therapy; (2) lesions ordinarily treated with 200 kv., which can be more efficiently treated with supervoltage radiation; and (3) improved palliation obtained with supervoltage radiation.

COURSE: 204

Room: D

Period: W-2

H. DABNEY KERR, M.D., Iowa City, Iowa

Irradiation of Malignant Tumors of the Pelvis

This will be a general discussion of the problem of delivering "adequate" doses of radiation to pelvic lesions, especially carcinoma of the cervix. It will necessarily have to include reference to basic physical problems or irradiation. The technique of irradiation in use currently at the State University of Iowa will be presented not as a fixed method but as one which seems to be working effectively. There will also be a

discussion of local and general complications, including osseous damage.

COURSE: 205

Room: D

Period: Th-2

MAURICE LENZ, M.D., New York City

Roentgen Therapy of Lymphosarcoma

The result of roentgen therapy of lymphosarcoma varies with inherent clinical characteristics, microscopic structure, assumed primary site, extent on admission and tumor dosage.

A detailed analysis will be given of the experience with this treatment at the Presbyterian Hospital, New York.

COURSE: 206

Room: B

Period: Th-2

T. LEUCUTIA, M.D., Detroit, Mich.

Radiation Therapy of Bone Tumors

(1) Osteogenic sarcoma. Radiation therapy is used in association with surgery in pre- or postoperative form in all types, except the pure osteolytic type, in which it is used alone. In the inoperable group, irradiation produces definite symptomatic relief. The five year survival for the entire series amounts to 17 per cent.

(2) Giant cell tumor. Here radiation therapy is the method of choice. There are two requisites: (a) irradiation must be carried out with gradually decreasing doses for nearly two years, and (b) a limited use of the affected bone must be made so as to prevent marked demineralization from disuse. The final results are, with few exceptions, good.

(3) Ewing's tumor. In the very early cases, radiation therapy may lead to occasional five year survival; in the others, only palliation is obtained, although the immediate response is often striking.

(4) Multiple myeloma. Radiation therapy leads to limited symptomatic relief, but no cure is possible.

(5) In the group of benign tumors, radiation therapy is of definite value in chondroma, myxoma, hemangioma, cystic conditions, etc.

The detailed procedure is presented in the various groups and the technique of irradiation illustrated. Final statistical data are included.

COURSE: 207

Room: D

Periods: T-1; W-1

CHARLES L. MARTIN, M.D., Dallas, Texas

Complete Care of Cancer of Mouth and Lip Including Cervical Metastases with Irradiation Alone

A plan for the complete radiological care of all stages of cancer of the mouth and lip will be de-

scribed. Although both radium and roentgen rays are used, the equipment is relatively inexpensive and the time of treatment is short. Much emphasis will be placed on the intensive irradiation of metastatic cervical glands, using a combined roentgen-ray and interstitial radium technique, which has yielded some very promising results. Detailed descriptions of the procedure used in a number of actual cases have been prepared for presentation.

COURSE: 208

Room: D

Period: T-2

WILLIAM S. NEWCOMET, M.D.,
Philadelphia, Pa.

Radium Therapy of Hemangiomas

The fact that hemangiomas occasionally disappear has led many physicians to defer treatment. Seventy per cent of these tumors enlarge shortly after birth; therefore treatment should be early, and thus save extension of the mass. Periodic growth. Portwine marks noticed at birth, rarely change in size and are not superficial. Pathologic difference, between the types, is responsible for variation of results from treatment. Comparison of the roentgen ray and radium. Complications during treatment. Difficulties encountered from previous forms of treatment, thickened scars, and keloids. Spontaneous ulceration, ulceration occurring during treatment. Complication from local lack of growth and function, deformity due to tumor, dermatitis, telangiectasis. Malignancy more likely in the pigmented variety. Treatment should be mild. Large masses upon the scalp should disappear and bald spots should be exceedingly rare. These tumors are usually more radiosensitive than hair. Discussion of treatment in the young infant, child and adult. Comparison with other types of treatment: surgery, electric modalities, caustics, injections of various solutions. General review of groups and individual cases, with emphasis upon bone changes observed in different types. Results observed immediately after treatment and ten to twenty years later. A plea for early treatment.

COURSE: 209

Room: C

Period: W-2

G. E. PFAHLER, M.D. Philadelphia, Pa.

Radiation Treatment of Cancer of the Breast

The technique for the treatment of cancer of the breast cannot be standardized. The treatment will be demonstrated for cancer of the breast in various stages, including positioning of patient for treatment.

There will also be a demonstration of some of the cases treated primarily and completely by irradiation,

also preoperative and postoperative irradiation, including the management of recurrences.

COURSE: 210

Room: C

Period: W-1

WALTER C. POPP, M.D., Rochester, Minnesota

Roentgen Therapy for Inflammatory Conditions

A short introduction will be given covering the theories as well as the experimental work done by various workers, and the action of roentgen rays on infectious processes will be discussed. The selection of techniques for the treatment of both acute and chronic processes will be emphasized. The handling of acute infections with small dosages will be considered in some detail. Methods of treatment of a variety of common infections will be presented as individual entities. Statistical information will be shown indicating the experience in the treatment of acute sinusitis at the Mayo Clinic.

COURSE: 211

Room: F

Period: W-2

GORDON E. RICHARDS, M.D.,
Toronto, Canada

Radiation Treatment of Oral Cancer

This discussion will deal with the treatment of cancer of the tongue, buccal mucosa, alveoli and soft and hard palate.

The greatest advance of the past ten years in the treatment of oral cancer has been a better understanding and more effective use of external and intraoral applications of roentgen rays combined with radium under certain conditions. In previous courses the subject of treatment of cancer of the tongue and buccal mucosa has been covered. In the present one the discussion is extended to include the alveoli, where the adoption of the methods outlined have resulted in a marked reduction of complications due to radionecrosis of bone, secondary infection as well as necrosis of soft tissue, resulting in slow healing and pain, most of which can be avoided by the adoption of methods of external irradiation. The course will be illustrated by colored lantern slides and graphic and statistical charts.

COURSE: 212

Room: J

Period: T-2

ROBERT B. TAFT, M.D., Charleston, S. C.

Dosage Measurement from a Clinical Standpoint

The various methods in common use for measuring clinical roentgen-ray dosage will be discussed, and the advantages and disadvantages of each pointed out. The value of the roentgen as a clinical unit will be compared with formerly used units. Pros and cons

for the direct dosage measurement on the skin of the patient throughout the treatment time will be given. Air measurements versus skin measurements will be outlined and tables given for backscattering at commonly used wavelengths. Brief mention will be made of methods of determining stray radiation around a laboratory, either medical or industrial. Half of the period will be taken up with the above, and round table discussion will follow. Throughout, an earnest effort will be made to keep the matter within the scope of the clinical radiologist who has little knowledge of, or interest in, pure physical measurements. The instructor, having had experience in both clinical and physical work, will attempt to narrow the far-too-wide gap between the clinician and physicist.

COURSE: 213

Room: A

Periods: T-2; W-2

B. P. WIDMANN, M.D., Philadelphia, Pa.

Radiation Therapy in Cancer of the Skin

Technical procedures for the radium and roentgen treatment of cancer of the skin will be reviewed and analyzed in detail. A definite predetermined plan of dosage has been formulated according to the estimated surface area and thickness of the lesion. Special emphasis will be placed on the value of low voltage roentgen rays (100-135 kv.), and a clinical comparison with radium will be made according to a great variety of patterns for single and multiple radium tubes with different sizes of fields, filters and distances. Conclusions will be drawn from a large clinical experience with massive and fractional doses. Determinations of the "maximum safe dose," the "minimal effective dose," the daily intensity and the probably best rate of administration will be considered with specific recommendations after a routine experience demonstrating results and skin tolerance.

DIAGNOSTIC ROENTGENOLOGY

COURSE: 301

Room: F

Period: W-1

PAUL A. BISHOP, M.D., Philadelphia, Pa.

Examination and Diagnosis of Lesions of the Temporomandibular Joint

The frequency with which injuries of the temporomandibular joint are overlooked, both clinically and roentgenographically, has led to an appalling number of permanent, serious disabilities of the mandible. A technique for the roentgenographic study of this joint is presented with lantern slide demonstration of acute and chronic injuries, as well as various non-traumatic conditions.

COURSE: 302

Room: F

Period: Th-1

PAUL A. BISHOP, M.D., Philadelphia, Pa.

A Classification of Fractures of the Ankle Based on the Mechanisms That Cause Them (Ashhurst and Bromer)

The use of "names" of fractures of the ankle is the cause of much confusion. "Pott's fracture" has been so popularized that, although it is a relatively infrequent fracture, it is the favorite clinical diagnosis in accident wards even in cases showing inward displacement, the opposite of a true Pott's fracture.

In 1922 Ashhurst and Bromer published a classification based on the mechanisms which cause the fractures, the characteristics of each being easily identified on roentgenograms. Thus, we are able to associate the various fractures produced by each acting force and separate those which, though similar anatomically, are caused by different forces.

It is a classification that justifies itself, and without classification "the relation of one lesion to another can be neither remembered nor understood in any department of knowledge; and comprehension is a prerequisite for intelligent memory and for rational diagnosis and treatment.

Lantern slide demonstration.

COURSE: 303

Room: C

Period: T-2

FRANKLIN B. BOGART, M.D.,
Chattanooga, Tennessee

Leukosarcoma

The literature will be briefly reviewed and cases will be presented which illustrate the typical Sternberg syndrome with mediastinal tumor and other variations of borderline cases which present some features of lymphosarcoma and some features of leukemia.

COURSE: 304

Room: G

Periods: W-2; Th-2

RALPH S. BROMER, M.D., Philadelphia, Pa.

The Differential Diagnosis of Skeletal Changes Occurring in Diseases of Infants and Children

The time allotted will be spent in discussing the differential roentgen diagnosis of skeletal changes occurring in diseases of infancy and childhood. All such diseases cannot be included in the time available for the course. Case material will be chosen from the following list: congenital syphilis, rickets, infantile scurvy, tuberculosis, lead poisoning, the blood dyscrasias, xanthomatosis and allied conditions, osteogenesis imperfecta, achondroplasia, mul-

tiple enchondromata, multiple cartilaginous exostoses, metastases caused by neuroblastoma, osteochondritis and endocrine disturbances. Wherever possible the early roentgen changes will be emphasized. The question of differential diagnosis will be approached from the standpoint of the predisposition of the various diseases to affect certain bones or certain areas of individual bones. Thus in the case of the long bones, differential roentgen signs of the disease processes in the epiphysis, the diaphysis, the metaphysis, the periosteum, cortex, etc., will be given in detail.

COURSE: 305

Room: B

Period: T-2

JAMES T. CASE, M.D., Chicago, Ill.

The Roentgenologic Diagnosis of Carcinoma of the Colon

In the diagnosis of carcinoma of the colon the pathological and anatomical considerations vary according to the location of the tumor in the right or left half of the colon. In colonic polyposis the symptomatology, like the pathology, varies with the position of the tumor in the right or left colon. Special technique is a matter of utmost importance. Repetition of the examination is often necessary.

The technique of examination for and the roentgenologic manifestations of cancer of the colon will be discussed and illustrated.

COURSE: 306

Room: B

Period: W-1

W. EDWARD CHAMBERLAIN, M.D., Philadelphia, Pa.

Technique and Interpretation of Air Myelography

Air has now been used successfully in hundreds of cases as the contrast medium for myelography. It has many advantages over other media but the roentgenographic requirements are very exacting.

Lumbar puncture vs. cisternal puncture for introduction of the air; methods of increasing scope of lumbar puncture route; adaptation of ordinary conventional roentgenographic apparatus to this work; essential factors in technique; stereoscopy essential in lateral as well as dorsal projections; stereoscopic shift across long axis of spine; value of comparing lateral projections with spine in hyperflexion and hyperextension; value of "over-exposing" films; oblique projections of little value except in cervical and upper thoracic regions; suggestions for after-care of patients.

COURSE: 307

Room: C

Period: Th-1

ARTHUR E. CHILDE, M.D., Toronto, Canada

**The Normal Encephalogram and Ventriculogram
Congenital Abnormalities of the Brain**

The roentgen technique of cerebral pneumography will be discussed and the importance of a few simple manipulations of the head during this procedure will be explained. This will be followed by a review of the normal anatomy of the ventricular system, basal cisterns and cortical markings. The pneumographic features of various congenital abnormalities will be shown.

COURSE: 308

Room: C

Period: F-1

ARTHUR E. CHILDE, M.D., Toronto, Canada

**The Pneumographic Diagnosis of Expanding,
Contracting and Atrophic
Intracranial Lesions**

The deformities produced by various types of expanding intracranial lesions will be shown. Encephalography is often used to determine the cause of epileptic seizures in patients who do not suffer from brain tumors, and some examples of atrophic and contracting intracranial lesions will also be illustrated.

COURSE: 309

Room: G

Period: F-1

**ARTHUR C. CHRISTIE, M.D.,
Washington, D. C.**

**The Diagnosis and Treatment of
Bronchiectasis**

History and Incidence.

Etiology and Pathogenesis.

Diagnosis.

Symptoms and signs. Necessity and means of early diagnosis. Iodized oils. Instillation of iodized oil by the passive method. Description of method. Illustrative slides to show different types of bronchiectasis and conditions which may require differential diagnosis.

Treatment.

Necessity for treating complicating inflammatory conditions. Medication. Postural drainage. Iodized oils. Bronchoscopic drainage.

Surgery: Applicability and limitations. Artificial pneumothorax. Phrenicectomy. Pneumectomy. Roentgen therapy: Rational basis for such treatment. Detailed descriptions of application, dosage, etc. Results illustrated by report of cases.

The aim of this course is to give a complete view of the diagnosis and treatment of this exceedingly

common disease in which the radiologist can play an important rôle in both fields.

COURSE: 310

Room: A

Period: Th-1

LEWIS GREGORY COLE, M.D.
White Plains, N. Y.

Pulmonary Tubercles, Their Etiology, Pathogenesis, and Roentgen Shadows They Cast

These subjects will be considered in their reverse order, first showing roentgenograms of pulmonary tubercles, then demonstrating the pathological findings of various tubercles, illustrated with Kodochrome photomicrographs, and subsequently presenting their pathogenesis and etiology. This reverse manner of presenting the subject should appeal to roentgenologists more than the rational sequence in the reverse order.

COURSE: 311

Room: G

Period: T-2

PEDRO L. FARIÑAS, M.D., Havana, Cuba

Bronchographic Examination in Primary Carcinoma of the Lungs

Bronchographic technique:

Simple bronchography (examination of the trachea and bronchi without contrast media).

Regular bronchography (examination of the trachea and bronchi with an opaque substance).

Mucosography (examination of the tracheo-bronchial mucosa coated with a very thin opaque layer).

Bronchographic aspects of the infiltrating and polypoid types of tumors.

Comparison between the bronchographic alterations and the anatomical specimen in the different types of bronchial tumors.

COURSE: 312

Room: B

Period: T-1

JOHN T. FARRELL, JR., M.D.,
Philadelphia, Pa.

Roentgen Diagnosis of Lesions of the Esophagus

The technique of roentgen examination of the esophagus with liquids, semi-solids, and solids, together with the indications and limitations of each, will first be presented. This will be followed by consideration of the roentgen anatomy and physiology. Study of pathological states will embrace the diagnosis and differential diagnosis of congenital, inflammatory, traumatic, functional, and neoplastic conditions of the organ.

COURSE: 313

Room: J

Periods: W-2; Th-2

C. A. GOOD, M.D., Rochester, Minnesota
The Small Intestine

All of the lesions commonly encountered in the small intestine will be discussed. Special emphasis will be placed upon the diagnosis of the organic lesions which are amenable to surgical treatment, such as enteritis, Meckel's diverticulum and benign and malignant tumors.

Particular attention will be paid to the roentgenoscopic method of examination and there will be a brief consideration of the clinical indications for a roentgenologic examination of the small intestine.

Lantern slides of roentgenograms and of colored photographs of the pathologic material will be presented.

COURSE: 314

Room: A

Period: W-1

GEORGE W. GRIER, M.D., Pittsburgh, Pa.

The Diagnosis of Congenital Heart Lesions in Children

Various malformations and congenital lesions of the heart will be discussed. Lesions which produce characteristic changes will be presented, as well as combinations of lesions. Other lesions in which the roentgen findings and clinical evidence combined will make a diagnosis will also be discussed. Films of a number of cases that have come to autopsy will be presented.

COURSE: 315

Room: H

Period: Th-2

A. O. HAMPTON, M.D., Washington, D. C.

The Roentgenologic Diagnosis of Pulmonary Infarction and Bronchial Occlusion; Technique and Interpretation of Venograms and their Importance in Prevention of Fatal Pulmonary Embolism

This discussion will include:

1. The appearance of bronchial occlusion in the lateral view of the chest.
2. The roentgen diagnosis of pulmonary infarction with special reference to the indications for venograms.
3. A few remarks on the technique and interpretation of venograms.
4. The importance of the roentgen examination of the chest and deep veins of the legs in the prevention of fatal pulmonary embolism.

COURSE: 316**Room: B****Periods: Th-1; F-1****HUGH F. HARE, M.D., Boston, Mass.****Myelography**

Myelography may be useful when performed with either oxygen, iodized oil (lipiodol) or pantopaque. It may be diagnostic or may be used as an aid to diagnosis.

The period will be devoted to a discussion of the various methods of myelography and their relative values in diagnosis.

COURSE: 317**Room: I****Periods: T-1; W-1****HERMAN HILLEBOE, M.D.,****U. S. Public Health Service****RUSSELL H. MORGAN, M.D., Chicago, Ill.****Mass Roentgenography of the Chest**

The development of mass roentgenography of the chest within the last decade has introduced a number of problems to the radiologist in the fields of diagnosis and technique. These problems will be discussed in detail. In addition, consideration will also be given to the planning and organization of mass roentgenographic programs in hospitals and in industry. Those taking the course will be asked to participate in the discussions and to present questions during the progress of the presentation.

COURSE: 318**Room: I****Period: T-2****F. J. HODGES, M.D., Ann Arbor, Mich.****Nontuberculous Lesions of the Chest**

In studying roentgenograms of the chest the likelihood of encountering some form of tuberculosis must always be considered. While it is not possible in all instances to eliminate tuberculosis as the primary cause of many intrathoracic abnormalities, a considerable number of intrathoracic conditions do provide tangible roentgenologic signs which lead to their positive identification. Even when positive diagnosis cannot be made, careful analysis of roentgenograms can provide diagnostic information of great value. Accordingly, in this course nontuberculous lesions presenting recognizable roentgenologic signs will be outlined, discussed and demonstrated with examples.

COURSE: 319**Room: B****Period: W-2****E. L. JENKINSON, M.D., Chicago, Ill.****Diaphragmatic Lesions Producing Gastrointestinal and Bizarre Cardiac Symptoms**

Congenital short esophagus and its differentiation from diaphragmatic hernia will be covered. The frequency of hiatal hernia (para-esophageal) will be considered. The importance of the hernia as to the symptoms it may cause will also be discussed. The identification of a hernia is often of paramount importance in ruling out a suspected cardiac lesion. Pain referable to the precordium is often caused by a hernia and it is by no means essential that the hernia be very large. Lesions of the diaphragm will be classified as follows:

1. Congenital short esophagus
2. Para-esophageal hernia
3. Evisceration
4. Absence of the diaphragm
5. Thoracic stomach
6. Eventration

COURSE: 320**Room: I****Period: W-2****A. S. MACMILLAN, M.D., Boston, Mass.****Roentgen Examination of the Accessory Nasal Sinuses**

The technique of examination of the patient for suspected sinus disease will be considered. Particular stress will be placed upon four positions which the instructor considers the irreducible minimum in the examination of the sinuses.

Acute and chronic sinusitis, the sinus involvement in allergy and in malignant disease as well as the cause of exophthalmus in sinus involvement.

There is a great deal of discussion among otolaryngologists as to the value of the roentgen ray as an aid in the diagnosis. An attempt will be made to talk about the practical points in interpretation.

COURSE: 321**Room: I****Period: Th-2****A. S. MACMILLAN, M.D., Boston, Mass.****Roentgen Examination of the Mastoids**

The technique of the examination of the patient for mastoid involvement in acute infections of the middle ear will be considered. Demonstrations of the various positions for the examination of the petrous pyramid in the search for involvement of this area as a complication of infection and invasions by new growths of the base of the skull and nasopharynx.

He will consider the rôle played by the roentgen ray in the determining of the optimum time for operation, the limitations of this type of examination

and the need for the roentgenologist to acquaint himself with the problems of the surgeon.

COURSE: 322

Room: C

Period: Th-2

L. G. RIGLER, M.D., Minneapolis, Minn.

Bronchial Obstruction

1. Bronchial obstruction is such an important factor in the production of pulmonary disease processes that a thorough understanding of its nature and effects is necessary.

2. The manifestations of bronchial obstruction tend to be uniform, regardless of the cause; that is, similar roentgenologic findings may be observed in such widely divergent processes as foreign bodies, asthma and lung tumors.

3. The changing diameter of the lumen of the trachea and bronchi during inspiration and expiration results in the production of two apparently opposite phenomena—emphysema and atelectasis—from the same obstructing mechanism.

4. A transition from obstructive emphysema to obstructive atelectasis, to bronchiectasis or to lung abscess may occur as a result of any type of obstruction, depending upon the nature, location and degree of the occlusion, the rapidity of its occurrence, and other incidental factors.

5. The roentgen examination of patients suspected of bronchial obstruction should include some or all of the following procedures: (1) fluoroscopy; (2) roentgenography in various positions and phases of respiration; (3) body section roentgenography; (4) bronchography.

6. Exact localization and determination of the nature of the bronchostenosis are important in order to permit proper surgical approach. Careful roentgen examination when added to the various other procedures, such as physical examination, bronchoscopy, and sputum examination should accurately delineate the nature, location, extent and effects of any type of bronchial obstruction.

7. An exposition of the roentgen findings in bronchial obstruction by means of slides and diagrams will be given.

COURSE: 323

Room: J

Period: F-1

SAMUEL A. ROBINS, M.D., Boston, Mass.

Utero-salpinography

This course concerns itself with the roentgen examination of the uterus and tubes by means of opaque media. The subject will be discussed under the following headings: (1) history; (2) apparatus and technique; (3) opaque media; (4) indications; (5) normal morphology; (6) physiologic variations;

(7) pathologic variations; (8) pregnancy; (9) tumors (fibroids, polypi, malignancy); (10) inflammatory changes of the tubes; (11) tubal pregnancy; (12) sterility; (13) post-therapeutic changes in the uterus; (14) contraindications; (15) dangers.

Lantern slides of various physiologic and pathologic conditions of the uterus and tubes will be shown to evaluate this method of examination.

COURSE: 324

Room: A

Period: T-1

L. R. SANTE, M.D., St. Louis, Mo.

Atypical Pneumonias

Their place in the roentgenological group of pneumonias.

Their roentgenological differentiation from other types of pneumonic involvement.

Their pathological variation from other types of pneumonia.

COURSE: 325

Room: I

Periods: Th-1; F-1

RICHARD SCHATZKI, M.D., Boston, Mass.

Small Bowel Enema

1. Technique of examining the small intestine with the help of the small bowel enema will be described.

2. Indications and contraindications will be discussed.

3. The method will be compared with other methods of examining the small bowel.

4. Practical examples will illustrate the discussion.

COURSE: 326

Room: H

Period: T-2

CARLOS H. SCHOTT, D.D.S., Cincinnati, Ohio

EDWARD L. BALL, D.D.S., Cincinnati, Ohio

Radiodontic Interpretation

Operating Room Procedure	Anatomic landmarks
	Positioning of the patient
	Placement and retention of film
	Angulation
	Exposing
	Mounting
	Economics
	Children's dentistry
	Operative dentistry
	Periodontia
Interpretation	Exodontia and oral surgery
	Prosthodontia and crown and bridge
	Orthodontia

COURSE: 327**Room: H****Period: W-2****HARRY M. WEBER, M.D., Rochester, Minn.****Chronic Ulcerative Colitis and Allied
Intestinal Disorders**

The name "chronic ulcerative colitis" may validly be applied to any non-neoplastic pathologic process in the large intestine in which inflammatory changes are predominant. In a restricted sense, however, the name denotes a specific disease entity, the etiology of which is still not established with certainty, but which has distinctive pathologic features. These characteristic pathologic characteristics are observed directly at proctosigmoidoscopic examination, and are reflected in the roentgenologic changes observed with the disease. These roentgenologic manifestations will be described and correlated with those of other etiologic types or more or less diffuse inflammatory processes commonly encountered in the colon. Emphasis will be on roentgenologic aspects, but the proctosigmoidoscopic manifestations will be demonstrated with a motion picture in color prepared by Dr. L. A. Buie and his associates in the Section on Proctology, Mayo Clinic.

COURSE: 328**Room: J****Periods: T-1; W-1****GEORGE M. WYATT, M.D., Washington, D. C.
W. S. RANDALL, M.D., Washington, D. C.****Benign and Malignant Lesions of Bone**

This material is selected from the cases admitted to the Walter Reed General Hospital in its capacity as a tumor center during World War II. Lantern slides include the roentgenographic, gross, and microscopic appearance of the various lesions.

Among the conditions to be considered are osteomyelitis, osteoid osteoma, fibrous dysplasia, eosinophilic granuloma, giant cell tumor, lymphoma, chondrosarcoma, osteogenic sarcoma, Ewing's tumor, neuroblastoma, and myeloma.

Attention will be directed to correlation of the roentgen appearance and gross pathology and to differential diagnosis of benign and malignant lesions.

COURSE: 329**Room: C****Period: T-1****BARTON R. YOUNG, M.D., Philadelphia, Pa.****Roentgen Diagnosis of Diseases of the Air and
Food Passages of the Neck; Planigraphy of
the Larynx**

The normal roentgen anatomy of the soft tissues of the air and food passages is reviewed in detail in the first part of the course. Roentgenoscopy is an indispensable preliminary procedure, so considerable time is devoted to a discussion of this part of the examination. The disturbances in deglutition due to tumor, infection or faulty innervation and the altered physiology and morphology of the larynx that result from any one of these conditions are readily detected by roentgenoscopic examination, and the roentgenoscopic appearances of some of the more common lesions are shown.

The changes in the air and food passages produced by foreign bodies and inflammatory and neoplastic diseases are demonstrated by exhibiting non-planigraphic and planigraphic roentgenograms. A technique for obtaining posteroanterior studies using non-planigraphic methods is outlined, and the value of this procedure for lateralizing laryngeal lesions is emphasized by showing illustrative cases.

The indications for body section roentgenography, and the results obtained from the application to the neck are presented. Planigraphy is of maximum value in the demonstration of tumors of the larynx but its superiority to conventional roentgen methods is not limited to the larynx. The planigraphic appearance of a number of interesting lesions in the larynx and cervical trachea is shown and discussed.

Section on Instruction ORDER SHEET

It is important to register for the Instruction Courses as early as possible since the number admitted to each course will be limited. *It is also very important that you list your first, second and third choice for each period.* All orders for tickets will be filled according to postmark on envelope.

Non-members, except full time graduate students in Radiology, will pay \$1.00 for each course-period or a maximum of \$5.00 for five or more such periods. *Non-members' fees must accompany this order sheet* and will not be returned unless cancellation is received before September 14, 1946.

Fill out the following (type or print):

..... Last Name First Name or Initials	Check	<input type="checkbox"/> Member
			<input type="checkbox"/> Guest
..... Street Address			<input type="checkbox"/> Graduate Student in Radiology at:
..... City State	

For convenience in selecting your courses, consult the condensed schedule on the following pages.

CLAIMING INSTRUCTION COURSE TICKETS

Beginning Monday, September 16 those who have sent in advance orders may secure their tickets at the Registration Desk located in the foyer on the Fourth Floor of the Netherland Plaza Hotel. Tickets may also be secured for courses not filled.

Please remember that the Sequential Courses are continuous courses and run from two to four periods. *No part of them is repeated.* They are numbered A to D. All other courses are single-period courses and a few are repeated

BE SURE TO FILL OUT SECOND AND THIRD CHOICES FOR EACH PERIOD

Period	First Choice		Second Choice		Third Choice	
	Course No.	Instructor	Course No.	Instructor	Course No.	Instructor
Tuesday	1					
	2					
Wednesday	1					
	2					
Thursday	1					
	2					
Friday	1					

Previous to September 7, 1946, send this order sheet to:
B. R. KIRKLIN, M.D., Mayo Clinic, Rochester, Minnesota.

After September 7, 1946, mail to:
B. R. KIRKLIN, M.D., American Roentgen Ray Society, Netherland Plaza Hotel,
Cincinnati 2, Ohio.

CONDENSED SCHEDULE OF COURSES ON TUESDAY

Code: T-1

1st PERIOD—8:00 to 9:15

Code: T-1

Sequential Courses, Physics and
Therapeutic Radiology

B—Golden	Roentgenology of the Small Intestine
C—Wasson	Anatomy of the Lungs
101—Braestrup	Common Causes of Radiation Hazards in Roentgenology
202—Fricke	Radium Therapy in Non-malignant Conditions
207—Martin	Radiation Treatment of Cancer of Lip and Mouth

Diagnostic Roentgenology

312—Farrell	Roentgen Diagnosis of Lesions of the Esophagus
317—Hilleboe Morgan	Mass Roentgenography of the Chest
324—Sante	Atypical Pneumonias
328—Wyatt Randall	Benign and Malignant Lesions of Bone
329—Young	Diagnosis of Diseases of the Air and Food Passages of the Neck. Planigraphy of the Larynx

Code: T-2

2nd PERIOD—9:30 to 10:45

Code: T-2

Physics and Therapeutic Radiology

104—Henny	Roentgen-Ray Film Characteristics and Calibration of Apparatus and Processing Solutions
108—Williams	Roentgen-Ray Circuits and Apparatus
208—Newcomet	Radium Therapy of Hemangiomas
212—Taft	Dosage Measurement from a Clinical Standpoint
213—Widmann	Radiation Therapy in Cancer of the Skin

Diagnostic Roentgenology

303—Bogart	Leukosarcoma
305—Case	Roentgenologic Diagnosis of Cancer of the Colon
311—Fariñas	Bronchographic Diagnosis of Bronchogenic Carcinoma
318—Hodges	Nontuberculous Lesions of the Chest
326—Schott Ball	Radiodontic Interpretation

CONDENSED SCHEDULE OF COURSES ON WEDNESDAY

Code: W-1

1st PERIOD—8:00 to 9:15

Code: W-1

Sequential Courses, Physics and
Therapeutic Radiology

B—Golden	Roentgenology of the Small Intestine
C—Wasson	Physiology and Mechanics of the Chest and Lungs
102—Failla	Dosage Problems in the use of Radioactive Isotopes
207—Martin	Radiation Treatment of Cancer of Lip and Mouth
210—Popp	Roentgen Therapy of Inflammatory Conditions

Diagnostic Roentgenology

301—Bishop	Lesions of the Temporomandibular Joint
306—Chamberlain	Technique and Interpretation of Air Myelography
314—Grier	Diagnosis of Congenital Heart Lesions in Children
317—Hilleboe Morgan	Mass Roentgenography of the Chest
328—Wyatt Randall	Benign and Malignant Lesions of Bone

Code: W-2

2nd PERIOD—9:30 to 10:45

Code: W-2

Physics and Therapeutic Radiology

103—Glasser	Atomic Energy in Radiology
204—Kerr	Irradiation of Malignant Tumors of the Pelvis
209—Pfahler	Radiation Treatment of Cancer of the Breast
211—Richards	Radiation Treatment of Oral Cancer
213—Widmann	Radiation Therapy in Cancer of the Skin

Diagnostic Roentgenology

304—Bromer	Differential Diagnosis of Skeletal Changes in Diseases of Children
313—Good	The Small Intestine
319—Jenkinson	Diaphragmatic Lesions
320—Macmillan	Roentgen Examination of Accessory Nasal Sinuses
327—Weber	Chronic Ulcerative Colitis and Allied Intestinal Disorders

CONDENSED SCHEDULE OF COURSES ON THURSDAY

Code: Th-1

1st PERIOD—8:00 to 9:15

Code: Th-1

Sequential Courses, Physics and
Therapeutic Radiology

B—Golden	Roentgenology of the Small Intestine
C—Wasson	Classification of Diseases of the Lungs
106—Taylor	Ionization Chambers and Their Uses
201—Ernst	Radiation Treatment of Cancer of the Cervix
203—Friedman	Supervoltage Roentgen Therapy

Diagnostic Roentgenology

302—Bishop	Fracture of the Ankle: Classification
307—Childe	Normal Encephalogram and Ventriculogram
310—Cole	Pulmonary Tubercles: Etiology, Pathogenesis, Their Roentgen Shadows
316—Hare	Myelography
325—Schatzki	Small Bowel Enema: Technique and Interpretation

Code: Th-2

2nd PERIOD—9:30 to 10:45

Code: Th-2

Sequential Courses, Physics and
Therapeutic Radiology

A—Donaldson	Radiologic Jurisprudence
D—Capurro	Topographic Roentgen-Ray Diagnosis of Tumors of Abdomen
105—Quimby	Dosage Calculation in Radium Therapy
205—Lenz	Roentgen Therapy of Lymphosarcoma
206—Leucutia	Radiation Therapy in Tumor of Bone

Diagnostic Roentgenology

304—Bromer	Differential Diagnosis of Skeletal Changes in Diseases of Children
313—Good	The Small Intestine
315—Hampton	Roentgen Diagnosis of Pulmonary Infarction and Bronchial Occlusion
321—Macmillan	Roentgen Examination of the Mastoids
322—Rigler	Bronchial Obstruction

CONDENSED SCHEDULE OF COURSES ON FRIDAY

Code: F-1 1st PERIOD—8:00 to 9:15 Code: F-1

Sequential Courses, Physics and
Therapeutic Radiology

Diagnostic Roentgenology

A—Donaldson	Radiologic Jurisprudence	308—Childe	Pneumographic Diagnosis of Expanding, Contracting and Atrophic Intracranial Lesions
C—Wasson	Roentgenologic Diagnosis Diseases of the Lungs		
D—Capurro	Topographic Roentgen-Ray Diagnosis of Tumors of the Abdomen	309—Christie	Diagnosis and Treatment of Bronchiectasis
107—Weatherwax	Dosage Calculations in Roentgen Therapy	316—Hare	Myelography
203—Friedman	Supervoltage Roentgen Therapy	323—Robins	Uterosalingography
		325—Schatzki	Small Bowel Enema: Technique and Interpretation

DR. CHAMBERLAIN TAKES PART IN WESTINGHOUSE CENTENNIAL FORUM

Dr. W. Edward Chamberlain, Director of the Department of Radiology, Temple University Hospital and Professor of Radiology of Temple University, and a member of the American Roentgen Ray Society since 1922, took part in the program of the George Westinghouse Centennial Forum held in Pittsburgh May 16, 17 and 18, 1946. This Forum was attended and participated in by the greatest scientific minds of this and other nations. The subject of the afternoon session of the first day of the Forum was "The Future of Atomic Energy." The speakers included Dr. Enrico Fermi who in 1938 won the Nobel Prize for his work on bombardment of the atom; Dr. J. Robert Oppenheimer, who planned, organized and directed the special atom laboratory at Los Alamos, New Mexico; Dr. Hugh S. Taylor, Dean of the Graduate School, Princeton University, who played a prominent part in mobilizing science during World War II, and Dr. Chamberlain. The biological phase of atomic energy was discussed by Dr. Chamberlain. His conclusion was that the new science of atomic energy will benefit biology and medicine not only directly, as when radioactive isotopes from cyclotron, betatron or chain-reaction-pile are put to work as tracers, or as therapeutic agents, but indirectly, through the spectacular advances which it has produced and will continue to produce in all scientific thinking. Each of the participants in the program of the Forum received the George Westinghouse Medal.

DR. FEDOR HAENISCH

Hamburg is in the British zone of German occupation and there is as yet no di-

rect mail communication with the United States. It was learned that Dr. Fedor Haenisch, since 1907 an honorary member of the American Roentgen Ray Society, had been ill, and that his roentgen department in the Barmbeck Hospital in Hamburg was a casualty of the war. One report was brought back from overseas by an American medical officer that Dr. Haenisch had died. This report led to his being included in the 1946 membership directory of the American Roentgen Ray Society as deceased. Dr. Haenisch's many friends in America will be glad to know that authentic news has been received, through roundabout but reliable channels, that he is still alive. The date of this information is May 27, 1946.

Dr. Haenisch is well known in the United States and has made numerous visits here, the last one being at the time of the Fifth International Congress of Radiology held in Chicago in 1937. In 1931 he delivered the Caldwell Lecture at the Atlantic City meeting of the American Roentgen Ray Society when Dr. Leopold Jachess was president. The topic was "Roentgenology as a Specialty." He discussed aspects of the relationships of roentgenology as of 1931 in Germany, which are of even more interest in the United States at present than they were then. This lecture was published in this JOURNAL in December, 1931.

RAMSAY SPILLMAN

DR. STONE RECEIVES MEDAL OF MERIT

Dr. Robert S. Stone has received from President Truman the Medal of Merit of the United States for his work on the "Manhattan Project" at Oak Ridge during World War II.



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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

SKELETAL SYSTEM

ANDERSON, ROGER, and O'NEIL, GORDON. Comminuted fractures of the distal end of the radius. *Surg., Gynec. & Obst.*, April, 1944, 78, 434-440.

The need of change in the methods of treating comminuted fractures of the distal end of the radius is evident from an evaluation of the average end-results, expressed by the patients as weakness, stiffness, soreness and deformity. Roentgenographic studies a year after the accident will, in a high percentage of cases, reveal a shortened radius, maltilted articular face, depressed or irregular joint surface, and a relative enlargement of the ulnar styloid.

The authors' clinical studies have demonstrated that these undesirable sequelae can be minimized by the use of protracted traction. Success calls for a prolonging of traction until consolidation is complete. While reduction with restoration of radial length is usually not too difficult to obtain, it is difficult to maintain because the intact ulnar shaft acts as a pivoting point for the contracting strong radial muscles.

The original shortening in many of these wrists fractures is due not altogether to overriding or telescoping of the many fragments but to an actual crushing of the cancellous bone. In these cases an apparent end-to-end reduction will not suffice because the articular fragment must be pulled out into its normal relationship with the ulna. Furthermore, it must be held in this extended position over a long period of time (eight to twelve weeks) awaiting not only the filling in but the aging of the cancellous bone to a degree sufficient to withstand the compressing force of the muscles.

All the anatomic and functional benefits of a satisfactory reduction sustained through traction until consolidation is complete, without fear of joint stiffness, are now possible with a new technique. The basic principles of this procedure are reduction obtained through skeletal traction in conjunction with skeletal half-pin countertraction, and immobilization by use of two slender rods instead of a cast. The

technique of applying the apparatus is described in detail.—*Mary Frances Vastine.*

SIRIS, IRWIN E., and RYAN, JOHN D. Fractures of the neck of the femur; analysis of 157 intracapsular and extracapsular fractures. *Surg., Gynec. & Obst.*, June, 1944, 78, 631-639.

This study analyzes the treatment of 157 consecutive fractures of the neck and intertrochanteric region of the femur seen on the Fracture Service of the Third (New York University) Division of Bellevue Hospital from January 1, 1941, to June 30, 1943. It is the authors' contention that immediate internal fixation enhances the ability of feeble, undernourished patients to survive, permits their ambulation in bed, reduces the incidence of potential complications, and allows early ambulation with crutches.

The following observations are included in the conclusions:

1. The treatment of choice for the intracapsular fractures in the aged and feeble is the immediate insertion of a Smith-Petersen cannulated 3-flanged nail or similar device.

2. The treatment of choice for the intertrochanteric fractures in the aged is the immediate insertion of a device incorporating the principle of a Smith-Petersen nail and Hawley bar, preferably a Moore-Blount blade plate.

3. For intertrochanteric fractures in the younger age group, bilateral Russell traction suspension has given very satisfactory results.

4. External pin fixation should not replace internal fixation for fractures of the hip or intertrochanteric region. Other than expediting the procedure of transfixion and minimizing the immediate trauma, it has none of the advantages of internal fixation. It is an extremely hazardous procedure and should be restricted to those who have had experience and are familiar with its technique.

5. It would seem that the patients who are in poor physical condition on admission have a better chance of survival if they are operated upon immediately rather than waiting to see if their general condition improves.

6. The use of local anesthesia, focal skin clips, and guide wires, and the three sets of indispensable roentgenograms, to determine (1) the accuracy of reduction and location of the skin clip in relation to the head of the femur, (2) the position of the guide wires, and (3) the position of the nail, will enhance the ability of the surgeon to expedite the proper insertion of the transfixion device.—*Mary Frances Vastine*.

PROCTOR, SAMUEL E., CAMPBELL, THOMAS A., and DOBELLE, MARTIN. March fractures of the tibia and femur. *Surg., Gynec. & Obst.*, April, 1944, 78, 415-418.

In this report, the authors discuss 7 tibial march fractures and 1 femoral march fracture encountered in three month period at the Station Hospital, Camp Reynolds, Greenville, Pennsylvania. This series includes the fourth reported case of an identical bilateral march fracture of the tibiae.

Differential Diagnosis. (1) Garré's sclerosing osteomyelitis; (2) periostitis; (3) osteogenic sarcoma or Ewing's sarcoma; (4) bone syphilis; (5) tuberculosis of bone.

Significant Findings in the 7 Cases of March Fracture.

1. Body type and age incidence. Patient was usually of the tall, fair Nordic type. The age average was nineteen years, eight months.

2. Mode of onset. In every instance there was sudden pain in the upper tibia followed by lameness. These symptoms always occurred during exercise such as sustained marching, double timing or obstacle course running.

3. Laboratory findings. The serum phosphatase was within the upper limits of normal. The serum calcium was consistently low and the serum phosphorus slightly elevated.

4. Roentgenological aspects . . . 4 stages are described:

Stage 1. Time: Seen in the first week following the sustained march fracture. A fine horizontal fracture line is seen through the upper shaft of the tibia, about 10 cm. from the knee joint.

Stage 2. Time: Seen in the second week following the sustained march fracture. A very slight amount of callus is seen at the medioposterior cortical fracture site. The callus is first seen in this position because it is the point of greatest weight-bearing stress. The fibula splints

the lateral fracture site which probably accounts for the lack of callus at this point.

Stage 3. Time: Seen in the third week following the sustained march fracture. A band of bone condensation is seen at the fracture site and bone absorption at immediate fracture line. Parallel cortical callus is present at medioposterior cortical fracture site. Callus is sometimes seen at the lateral fracture site during this stage.

Stage 4. Time: Seen in the fourth week up to the twelfth week following the sustained march fracture. Cortical callus and bone condensation are increasing. Fracture line has disappeared. After the twelfth week the callus begins to absorb.

Mechanics of March Fracture Formation. A rhythmical mechanical stress at the point of greatest bone bending is the salient factor in the production of this type of fracture. The rhythmical mechanical stress is the alternate thrust of the body weight down each leg during each step. The tibia and the femur are rhythmically bent anterolaterally with each step and the microtraumas occur at the sites of greatest bone bending (which was at the upper shaft of the tibia and the lower shaft of the femur in the cases discussed).—*Mary Frances Vastine*.

BERTRAM, D. R. "Stress" fracture of bone. *Brit. J. Radiol.*, Aug., 1944, 17, 257-258.

Since the publication of an article on stress or fatigue fracture in February, 1943, a careful watch has been kept for roentgen evidence of such fractures in other bones than the metatarsals. The author works in a Naval hospital devoted chiefly to the treatment of orthopedic conditions and the fact that only 2 such cases have been seen in twelve months indicates the rarity of this condition in the long bones, at least in the Navy.

Both these patients were young men of eighteen. One had a stress fracture of the femur and the other one of both tibiae. The latter patient gave history of a stress fracture two years previous to entering the Navy. His occupation had been sedentary and he did not indulge in games or sports. Both cases began with pain in the affected region. Roentgenograms are given showing the typical picture of

stress fracture in both cases.—*Audrey G. Morgan.*

ALLENDE, GUILLERMO, and FREYTES, MANUEL V. Luxación-fractura de Lisfranc. (Luxation fracture of Lisfranc's joint.) *Rev. ortop. y traumatol.*, July, 1944, 14, 63-74.

Three cases of luxation of Lisfranc's joint are described and illustrated with roentgenograms. In addition to the dislocation, there were slight fractures of the bases of the metatarsals which is common. The anatomy of the joint is reviewed, showing that when a person falls on the tip of the foot the weight of the body is transmitted to the first metatarsal, which may resist, fracture or be dislocated. A classification of these dislocations is given. It has been held that they recover without treatment but the descriptions of the authors' cases, 2 of which came for treatment late, show that early treatment is advisable. It is generally possible to reduce the dislocation manually, but if not, operation may be performed, removing any troublesome projecting bones and performing arthrodesis. The authors believe that treatment with Cuendet's traction apparatus, which is illustrated, gives good results in most cases, though it does not correct the lateral deviation which occurred in one of their cases.—*Audrey G. Morgan.*

VOEGELIN, ADRIAN W., and MCCALL, MILTON L. Some acquired bony abnormalities influencing the conduct of labor, with reports of recent cases. *Am. J. Obst. & Gynec.*, Sept., 1944, 48, 361-370.

This study is concerned only with those pelvic abnormalities which have been acquired, due to either trauma, specific disease, or to neoplasms.

Trauma. Until the advent of fast motor travel in recent years, the incidence of pelvic fracture as a complication of labor was comparatively rare.

Eighty per cent of the cases of pelvic fracture have multiple fractures. Common sites are the rami of the pubis and ischium, and the alae of the ilium.

Fractures of the pelvis are usually the result of severe impact. Eighty per cent now occur in automobile accidents. The injury commonly occurs as the result of the passenger in the rear seat of an automobile being thrown forcibly against the side of the car.

From the obstetric standpoint, the lateral

rushing fractures are the most important because greater distortion of the pelvic inlet is likely to result. Fracture of the descending ramus of the pubis may be of serious import because the outlet of the pelvis may be encroached upon. A severe fracture about the symphysis pubis with separation or displacement is dangerous because of the possibility of injury to the urethra or bladder upon descent of the presenting part.

After a few years have passed, some of the most severe cases of pelvic fracture are surprisingly free of excessive callus formation or severe pelvic deformity. Often nature helps to compensate for these deformities by bringing about premature labor or producing a small baby.

Dislocation of the joints due to trauma may cause concern. Dislocation of the head of the femur usually causes no marked pelvic deformity even though it be congenital. In bilateral subluxation, the heads of the femora may project into the pelvis through the sciatic notches when the patient is put in the normal abduction position for labor. Such a case may be delivered by abandoning the obstetric position and adducting the legs.

Forward displacements of the coccyx with ankylosis of the sacrococcygeal joint due to an old injury may cause dystocia at the pelvic outlet but it usually is not serious.

Specific Disease. These cases are uncommon; those due to bacteria, especially tuberculosis, are seen most frequently. Tuberculous coxitis when it occurs in early life nearly always causes an obliquely contracted pelvis. The distortion is usually on the healthy side. The diseased leg is shortened so that in walking the body weight is transmitted in great part to the well leg. This tends to flatten the iliopectineal line and the sacrum is rotated to some degree about its vertical axis, so that its anterior surface looks toward the well side. The pelvis is affected throughout from the inlet to the outlet.

A typical kyphotic pelvis (usually tuberculous in origin) is characterized by an elongated conjugata vera and a contracted outlet. This is brought about because the body weight transmitted to the lumbosacral hump is directed both downward and backward. The promontory of the sacrum is drawn backward and upward, the posterior extremities of the innominate bones are pushed apart and their lower portions inward. The lower portion of the sacrum is pushed forward. Thus, in a kyphotic pelvis the

distance between the iliac crests is equal to, or greater than, that between the two trochanters. The diagonal conjugate is deep. The biischial distance is small and also the posterior sagittal measurement.

In the authors' experience osteomyelitis of the pelvic bones has not caused severe pelvic dystocia. In cases of old poliomyelitis with unilateral lameness, there is sometimes a slight obliquity of the pelvis, but never as severe as in those cases in which the lameness is due to hip disease.

Neoplasms. Neoplasms of the spine ordinarily cause no difficulty in pregnancy unless they involve the sacrococcygeal region. Tumors of the pelvic girdle can, however, cause serious dystocia. Of the malignant tumors, 5 per cent of osteogenic sarcomas, which is a neoplasm of young people, occur in pelvic bones.

The benign neoplasms are the most common. These are usually bony exostoses which may be found over the iliopectineal eminences, the crests of the pubis, or over the pelvic joints. Like the enchondromas, which grow rapidly during pregnancy, they often cause serious obstruction to labor.—*Mary Frances Vastine.*

JUNGSMANN, H. Osteochondritis of patella. *Brit. J. Radiol.*, Oct., 1944, 17, 305-307.

In the majority of children the patella ossifies from one nucleus which appears on the roentgenogram at the age of from three to five years. In some cases secondary centers of ossification appear at puberty and these may become the site of osteochondritis. The secondary centers show blurred outlines but these appear on both sides though usually only one side is diseased clinically. This is called Sindig-Larsen-Johansson's disease from the authors who first described it.

Osteochondritis of the primary center is rarer and only a few cases have been described. Unlike osteochondritis of the secondary centers it is almost always unilateral. A case is described which was followed up for four years from its beginning to the healing stage. The patient, a boy of nine, first complained of pain and difficulty of movement of the left knee joint in July, 1939. Roentgenograms of both knees are given; the right normal one showed the normal size of the patella for that age. The left showed decrease in width and increase in length of the patella, apparently caused by the upper and lower poles being pulled apart. The outline was poorly defined, the structure was

irregular and there were signs of sclerosis near the upper part of the patella. A roentgen diagnosis of osteochondritis was made but tuberculosis was suspected clinically and the patient was treated accordingly. In 1940 the roentgen appearance definitely ruled out tuberculosis. In 1943 the left patella was well outlined but sclerosis and small cyst-like areas of rarefaction were seen throughout it. A horizontal line dividing the upper from the lower part indicated that the bone had been fragmented and the fragments had later fused. At the posterior end of the line there was a small bony defect partly filled by two small separate pieces of bone. The roentgen appearances were the same as those described by other authors in this disease. Experimental work in the production of osteochondritis in the patella is described. Mau believes that the rarity of the disease in the patella is due to its abundant blood supply in spite of the fact that the strain on the patella is enormous and it is subjected to many injuries.—*Audrey G. Morgan.*

BRAILS福德, JAMES F. The investigation of sciatica and lumbago—radiological aspect. *Brit. J. Radiol.*, Oct., 1944, 17, 308-311; correction, Nov., 1944, 17, 351.

The cause of low back pain is one of the much disputed questions in medicine. It has been attributed to a multitude of causes including maldevelopment and injury, inflammation or new-growth in the skeletal, nervous, gastrointestinal, vascular and genitourinary symptoms and because of the difficulty of determining a definite cause many physicians attribute it to hysteria. Certain clinicians advise against roentgenography because of the danger of increasing the hysterical element, but the author strongly advises roentgen examination as the causes, which are not uniform, may often be shown by such examination. It may show trauma of the lumbosacral region; there may be no roentgen changes in the first few weeks but later reactive changes are seen. Irregularities in the development of the lumbosacral elements are frequent and the gross defects of the lumbosacral area found in the various sorts of spina bifida are readily shown by roentgenograms. They may show spondylolisthesis, which may be caused in the infant by difficult delivery and spondylolisthesis in the mother may cause such difficulty in delivery. Lumbosacral lesions associated with general diseases of the skeleton may be shown by roentgen examination as well

as trauma and local disease of the lumbosacral area. Injuries of this region may cause inflammatory conditions which already existed in a latent state, such as tuberculosis, syphilis and new-growths to become manifest. Lesions of the intervertebral discs and protrusions from the discs into the spinal canal may be shown by roentgen examination. When this was first discovered many surgeons thought this was the sole cause of low back pain and that it could be remedied by operation; such of course did not prove to be the case; moreover operation on the disc may cause other injuries to such an extent that the State Corporation Insurance Fund of California reports compensable disability in 100 per cent of patients operated on for disc injuries. Their report emphasizes the importance of thorough investigation of the cause of the injury, particularly the continuation of pain following it, and of any hysterical element in the case before resorting to drastic surgery.—*Audrey G. Morgan.*

LAGOMARSINO, ENRIQUE H. El granuloma lipofágico de la rodilla. (Lipophagic granuloma of the knee.) *Rev. ortop. y traumatol.*, July, 1944, 14, 43-55.

Recently Max Biedl published a series of articles in the *Arch. f. klin. Chir.* in which he described what he calls lipophagic granuloma of the knee, differentiating it from the various pictures of lipoid disease. The author has recently seen a case which belongs to this group of lipoid granulomas and describes it in detail, illustrating it with photographs, roentgenograms and photomicrographs of the histopathological findings.

The patient was a man of forty-five who in 1935 fractured his right knee. Complete recovery followed operation. In June, 1937, he fractured the left knee and this, too, apparently recovered completely after operation. But in five or six months the knee began to swell; it improved on diathermy but the swelling recurred several times, and when he came to the author he presented the swollen condition of the left knee joint seen in the photographs.

In addition to the pasty swelling of the joint, palpation showed two tumors the size of dove's eggs. Operation under local anesthesia showed a wine-red tumor tissue between the aponeurosis and the synovial plane which was dotted with large yellow spots. Histopathological examination showed it was granulation tissue very rich in cells of a xanthomatous type,

and containing sudanophil granulations. The cavity was curetted and the patient given roentgen therapy, a total dose of 2,000 r being given in two weeks. He made an uneventful recovery and when seen a year later there was no recurrence.

Polarimetric examination is a good means of deciding whether a disease of the knee joint is a simple lipoid process or a lipophagic one. If the foam cells are birefringent, it is a true lipomatous process while if they are not it is a lipophagic disease. Unfortunately, this examination could not be made in this case.

Biedl's 2 cases are reviewed. Trauma with intratissular hemorrhage is probably a factor in the production of this disease; histological examination indicates that the lipophagic cells are reticuloendothelial in origin. The hemosiderin pigment found in this case is in agreement with the observation of Harbitz who found this pigment in all of 37 cases of lipophagic granuloma examined.—*Audrey G. Morgan.*

LYFORD, JOHN III, SCOTT, ROGER B., and JOHNSON, ROBERT W., JR. Polyarticular arthritis and osteomyelitis due to granuloma inguinale. *Am. J. Syph., Gonorr. & Ven. Dis.*, Sept., 1944, 28, 588-610.

Extragenital granuloma inguinale is not often reported, and bone and joint lesions of the disease are rare. Lyford, Scott and Johnson report 3 proved cases of polyarticular arthritis and osteomyelitis in Negroes, 1 of which had disseminated bone and joint lesions and 2 cases had osteomyelitis in addition to soft tissue lesions. In the one, involvement of the right elbow with eventual lesions in both ankles, hands, wrists, the other elbow, skull, clavicle and acromion process was present. Roentgen examination revealed a diffuse osteolytic type of lesion with absence of sequestration and involucrum. Death occurred and final studies had not been completed at the time of the report. A second case had lesions in the third and fourth lumbar bodies and left hip. No cure had taken place at the time of the report. The third case had a lesion progressing from the hand to the radius requiring amputation of the arm with apparent cure. Biopsy from all 3 cases showed granulation tissue, plasma cells and macrophages containing Donovan bodies. Pathologically the bone lesions revealed no pus but granulation tissue. The possibility that the

disease is systemic is suggested with hematogenous spread.—*Leo A. Nash.*

MAROTTOLI, OSCAR R., and CELORIA, FRANCISCO. Osteomielitis crónicas a forma pseudotumoral. (Chronic osteomyelitis of the pseudotumoral form.) *Rev. ortop. y traumatol.*, July, 1944, 14, 3-22.

The authors describe 6 cases of this disease and illustrate them with roentgenograms. The patients all recovered after operation. The special importance of this condition lies in the fact that it is often mistakenly diagnosed as bone sarcoma, while as a matter of fact it is only an attenuated form of osteomyelitis.

It differs from other forms of chronic osteomyelitis only in its tendency to form tumors, generally of the diaphyses of the long bones, particularly the femur and tibia; pressure of the tumor on the soft parts may be so great as to cause ulceration of the skin. The hyperostosis of bone originates from the cortex and it encroaches on and may completely obliterate the marrow cavity. Sometimes the tumor takes the form of an onion with concentric layers of bone. There may be cavities in the new-formed bone containing sequestra or a gelatinous or albuminous mass representing the marrow. The microscopic lesions are pure condensation with decreased numbers and size of the haversian canals. The causative agent is generally the *Staphylococcus albus* or *aureus* but sometimes no bacteria can be found. The most characteristic clinical symptom is pain which may vary greatly in degree. Generally the regional glands are not enlarged. The blood changes are only those of general infection but the sedimentation rate is always increased. Alkaline phosphates are not increased, which is a point in differentiation from osteogenetic sarcomas. In sarcoma, too, the pain is generally more intense and persistent and the temperature higher; the soft parts are more involved and the general health is more seriously affected; the roentgenogram shows a more irregular border in sarcoma than in osteomyelitis; sarcoma may cause an onion form of tumor but it is not so large or so regular in form as that of osteomyelitis.

Roentgen examination in these pseudotumoral forms of osteomyelitis shows a thickening of the bone cortex of the eburnated form which is very opaque so that no trabeculation shows. The new-formed bone is cylindrical or fusiform with regular outlines.

Treatment is surgical, a free incision being made, the excess bone removed and drainage established. This treatment generally results in recovery.—*Audrey G. Morgan.*

GARAVANO, PEDRO H., and SCHAJOWICZ, FRITZ. Mixoma oseo. (Myxoma of bone.) *Rev. ortop. y traumatol.*, July, 1944, 14, 56-62.

The patient, a man of thirty-six, came for examination in April, 1940; he had had a sharp pain in the posterior part of the right elbow for about a year which increased on pressure with the fingers. Recently swelling had appeared at this site. There was a tumor with a smooth surface in the right olecranon region; it was the size of a hen's egg and hard as bone except at one point at the tip of the olecranon. There were no enlarged epitrochlear or axillary glands. Extension and flexion of the elbow were normal. Roentgen examination showed a tumor of the geodic type, transparent and cystic, which had invaded all the upper epiphysis of the ulna and extended downward 8 or 9 cm. into the diaphysis, occluding the marrow cavity. It was surrounded by a thin shell of bone and showed no periosteal reaction. The joint lumen was preserved though the tumor extended to it. Operation on May 24, 1940, showed a lobulated mass of grayish color with a distinct plane of cleavage from the superficial tissues so that it could be removed in its entirety, using a spatula as a wedge. The cavity was curetted and hemostasis brought about by filling it with tampons wet with warm physiological salt solution. A graft from the tibia was inserted into the defect in the bone. A cast was applied with the elbow at a right angle. Recovery was uneventful.

Microscopic examination showed that the tumor was a pure myxoma without the giant cells characteristic of the tumor described by Ewing. Some zones were very rich in cells but there were no signs of malignancy. Roentgen examination five months after the operation showed that the graft had taken perfectly and movements of extension and flexion of the elbow were complete.—*Audrey G. Morgan.*

MOLINA, VICENTE A. Síndrome de Volkmann; estado actual de su tratamiento. (Volkmann's syndrome; present status of treatment.) *Rev. ortop. y traumatol.*, Jan., 1944, 13, 174-189.

Volkmann's ischemic contracture is a serious complication, fortunately not very frequent, of

severe injury of the limbs, with or without fracture, commonest in the upper limbs. Most of the patients are children and it is particularly frequent in patients with supracondylar fracture. The exact cause of the condition is not known but it is certain that circulatory disturbances and irritative lesions of the periarterial sympathetic nervous system are factors in its causation. Sometimes it is brought about by injuries of the nerves during operation and sometimes by improperly adjusted plaster casts.

Treatment may be surgical, orthopedic and physiotherapeutic. Early operation in the beginning of the condition may prevent the development of the later more serious stages. Operations that may be performed at this time are aponeurotomy, periarterial sympathectomy and arteriectomy. Delayed operations some weeks after the beginning of the disease may improve the condition; these operations are sympathectomy, arteriectomy and treatment of the nerve lesions. Late operations can only partially correct the sequels of the disease; these are operations on the bones, muscles and tendons. Orthopedic treatment must be well chosen and prolonged.

Plaster casts should always be adjusted carefully and the patient watched so that if the slightest sign of contracture develops the cast may be removed and correction made. As the condition is sometimes caused by manipulations in reducing fractures these should always be carried out as gently and carefully as possible.—*Audrey G. Morgan.*

GARBER, ROBERT L. Rhabdomyosarcoma of the extremities. *Radiology*, June, 1944, 42, 595-596.

Rhabdomyoma occurs chiefly in the genitourinary tract, though some cases have been described in the extremities, chiefly the lower.

The only effective treatment is surgical removal and then they show a tendency to local recurrence. Leucutia reports a series of 3 cases of rhabdomyosarcoma, in a total of 3,000 cases of malignant tumor of all types, none of which was influenced by irradiation.

The author describes a case in a man of sixty-eight who for about six months had had pain in the left shoulder. When he came for examination there was a large firm mass at the upper end of the humerus, definite limitation of movement and constant pain. Roentgen examination showed a large, irregular area of

destruction at the upper end of the humerus with bony spicules extending into the soft tissue mass. The appearance suggested primary osteogenic sarcoma. There was no evidence of metastasis. Roentgen treatment had no effect and the tumor was removed surgically. It was a large hemorrhagic tumor the size of a grape fruit involving the upper third of the humerus. A photomicrograph of a section is given. It shows cellular pleomorphism and many giant multinucleated cells. There were areas of degeneration, necrosis and hemorrhage. It apparently originated in skeletal muscle, making it a rhabdomyosarcoma.

The wound healed promptly; six months later the patient was in good general condition but movement of the arm was limited.—*Audrey G. Morgan.*

BLOOD AND LYMPH SYSTEM

SMITH, BEVERLY C., and QUIMBY, EDITH H.

The use of radioactive sodium in studies of circulation in patients with peripheral vascular disease; preliminary report. *Surg., Gynec. & Obst.*, Aug., 1944, 79, 142-147.

The viability of an extremity is dependent upon the arterial blood which reaches it through its main arteries or through their branches which constitute the collateral circulation. Prognosis and results of therapy in peripheral vascular disease could be more accurately judged if a simple objective method were available for measuring the arterial flow through these two circulations. Most of the available physiological tests are clinically impracticable. In searching for a practical procedure, it was decided that if radioactive sodium were injected intravenously at the antecubital fossa, its arrival in other parts of the body could be recorded by a Geiger-Müller counter and thus circulation time from arm to any desired region obtained. Since there is constant interchange of sodium between blood plasma and extravascular fluid, the amount of radioactive isotope will increase in any particular region until equilibrium is attained. This can be followed by the rate of response of the counter. The manner in which this equilibrium is built up may be related to the degree of pathological change in the vessels of the extremity.

In addition to normals, the following types of case have been studied: arteriosclerosis, with and without diabetes, peripheral thrombosis and embolus, thromboangiitis obliterans, sclero-

derma, Raynaud's disease, Raynaud's syndrome, aneurysm, frostbite, immersion foot, and essential hypertension. To date, approximately 60 patients have been studied.

The results obtained have been definite, objective, and uninfluenced by the observer, the environment, or the condition of the patient (except for his disease). Information obtained has supplemented clinical and laboratory methods, yielding valuable data concerning the patency of the main and collateral circulation. In particular, preoperative studies of patients coming to amputation have been valuable in confirming clinical impressions of competency of main or collateral circulation to permit healing below the knee joint.

There have been no untoward local or systemic reactions to the use of the radioactive isotope. Many of the patients observed have been ambulatory and have not required hospitalization for this study. The radioactive sodium is prepared in the cyclotron by bombarding sodium metaborate with deuterons. In the material finally obtained after treatment of the metaborate containing the active atoms, the radioactive isotope forms a very small percentage of all the sodium atoms present. In 5 cc. of normal saline containing 200 microcuries of radiosodium, fewer than 1 in 10 million sodium atoms are active; the rest are ordinary stable isotope. However, the ordinary and radioactive ones are indistinguishable and inseparable until the radioactive ones disintegrate. In the instant of disintegrating, the radioactive atoms emit β particles and γ rays, and become atoms of stable magnesium. The amount of magnesium thus formed is entirely too small to have any demonstrable effect, being, for the quantities here cited, the order of a millionth of a microgram. The radiation detected by the Geiger-Müller tube and the recording apparatus gives an audible click for every disintegration (or every 2, 4, 8, 16, or 32 disintegrations according to a scaling adjustment). The amount of radiation the patient's body receives in the total disintegration of the amount under discussion is less than 1 roentgen.

—*Mary Frances Vastine.*

STOCK, MAURICE F. Hereditary hemorrhagic telangiectasia (Osler's disease); review of the literature and report of cases. *Arch. Otolaryng.*, Aug., 1944, 40, 108-114.

Hereditary hemorrhagic telangiectasia is a rare disease, probably due to mesenchymal

dysplasia. It is characterized by the presence of multiple acquired angiomas or telangiectases of varying distribution and number with a marked tendency to bleed spontaneously or from slight trauma. The disease is transmitted as a dominant characteristic. The initial symptom usually consists of abnormally profuse epistaxis beginning about puberty. This is followed by the development of multiple telangiectasia of the skin and mucous membranes from the age of twenty-five to thirty-five years. Hemorrhage from the nasal mucosa is most frequent, and all symptoms tend to reach their greatest severity during the fourth decade. The average mortality rate is 4 per cent.

Macroscopic Picture. The lesions vary in color from red to purple and in size and form from pinpoint spots to the larger nodular forms and the large "spider form" or nevus araneus. They blanch on pressure, unless a hemorrhage has taken place recently. They are most commonly found in the nasal mucosa, the skin of the face, the buccal mucosa, the lips, the tongue, the floor of the mouth, the scalp, the ear, the conjunctivas and the finger tips. Other common sites are the ear drums, the palate, the pharynx, the larynx, the trachea, the esophagus, the stomach, the intestines, the bladder, the uterus and the urethra.

Microscopic Picture. The lesion usually shows an increased number of dilated vessels with greatly thinned walls. The tissues covering the vessels are usually thinned, which permits hemorrhage to occur from trivial causes. Thrombosis is frequent and probably explains the tendency of the lesions to disappear spontaneously, while new ones arise elsewhere.

Differential Diagnosis. In the differential diagnosis one must consider the telangiectases due to syphilis, senility, pregnancy and lead poisoning. The disease must also be differentiated from leukemia, aleukemia, aplastic anemia, thrombopenic purpura hemorrhagica, hemophilia, cirrhosis of the liver, cancer, persistent macular eruption, familial hemorrhagic purpura, Banti's, Gaucher's and Hodgkin's diseases and Sturge-Weber disease.

Treatment. This consists of various measures adopted to achieve immediate hemostasis, together with transfusions if necessary. Permanent cures have been reported following various types of cauterization and radiation therapy. It has been reported that the type 4 (Moss) blood group is intolerant of transfusions in the presence of splenohepatomegaly.

Hereditary Factor. In only a few instances has the disease been traced through six generations although there are numerous reports dealing with its transmission through three or four generations. This probably indicates self limitation of the hereditary transmission of the disease.

The disease is usually held to be hereditary, but it seems that at least 20 per cent of the recorded cases have lacked a family history of the occurrence of the disease and were not examples of atavism.

The author presents a review of the literature from 1933 to 1944 and adds 7 new case reports.—*Mary Frances Vastine.*

MAHORNER, HOWARD. Control of pain in post-traumatic vascular disturbances. (Editorial.) *Surg., Gynec. & Obst.*, June, 1944, 78, 657.

After trauma, complete recovery does not always follow in a reasonable time. In a large group of patients disability persists abnormally long in spite of physiotherapy and other means to obviate the remaining symptoms.

In 1915, Leriche performed a periarterial sympathectomy on a brachial artery for a vasomotor phenomenon associated with pain, cyanosis, and a cold extremity in a man who had had a bullet wound of the axilla. The burning pain was immediately relieved. This was a new approach to the relief of such pains. Since then, however, the rôle of the sympathetic nervous system in the post-traumatic syndrome has not been widely appreciated, and measures to affect the pain by attacks on the sympathetic nerves are not in common use. Perhaps there are two reasons why this has not been widely accepted. First, there is no experimental proof from the lower animals and, second, it is generally taught that pain travels over sensory nerves only.

The conditions included under this discussion are causalgia, sympathalgia, Sudeck's atrophy, vague pains not strictly deserving designation by any of these terms; and in addition, painfully stiff joints and ischemic contractures of the Volkmann type.—*Mary Frances Vastine.*

SAMUEL, ERIC. Venography in primary axillary vein thrombosis. *Brit. J. Radiol.*, March, 1944, 17, 83-85.

Little has been written about venography as a means of diagnosis of primary thrombosis of the axillary vein. Andersson in 1938 first used the uroselectan group of dyes in the diagnosis of this condition. Objection has been made to

the use of radiopaque dyes for this purpose because they cause sclerosis, but in the 2 case in which the author used the method there was no further extension of the thrombosis.

He reports 1 case in a young soldier twenty-two years of age who was admitted to a military hospital complaining of painless swelling of the left arm which had persisted for two weeks. Twenty cubic centimeters of pyelectan solution were injected into the antecubital vein and films taken after 10 cc. had been injected, after the whole amount had been injected and one minute after the completion of the injection. The dye in the axillary vein could be followed as far as the outer border of the third rib where it stopped abruptly; beyond this a collateral venous circulation could be seen extending around the neck of the scapula. Normal and pathological venograms are given. It is probable that this condition is caused by trauma.—*Audrey G. Morgan.*

GENERAL

TOTH, BENEDICT J. Accidental trauma and tumor metastasis. *Radiology*, June, 1944, 42, 579-590.

There has been a great deal of argument as to whether trauma can cause tumor metastasis. In connection with this question 2 cases are presented. The first patient was a man of fifty-five. A part of a machine with which he was working fell on him and caused severe injuries of the right arm and a deep laceration of the lower part of the right thigh. Roentgenograms showed an oblique fracture of the radius about an inch above the joint surface. On reduction of the tumor a soft pedunculated tumor was found on the flexor surface of the left forearm, which was removed. A metastatic tumor developed in the right wrist, localized first in the subcutaneous tissues and gradually invading the bone. Other metastases developed and the primary tumor was finally found to be one of the larger nodules in the right lung close to the hilum. Because of the difficulty of determining whether the metastases were caused by the injury a slight injury was inflicted on the anterior surface of the right leg. When the patient died more than two months later, there was no evidence of metastasis at the site of this injury. A metastatic tumor from trauma should be at the site of the trauma.

The second case was in a man of sixty-four who fell from a roof striking his head on a platform. There was a fracture of the first lumbar

vertebra, and a small palpable mass in the epigastrium. About three months after the accident the patient died. Autopsy showed a fungating carcinoma of the stomach with metastases in the regional lymph nodes, the liver, various ribs, both clavicles and the sixth and seventh thoracic vertebrae, but none in the fractured first lumbar vertebra.

After a detailed discussion of the evidence the author concludes that it is unlikely that trauma causes tumor metastases. It has not been possible to produce metastatic tumors in mice and rats by fracturing their bones. The cases of assumed traumatic causation of metastases reported in the literature do not show satisfactory scientific evidence of a definite causal relationship.—*Audrey G. Morgan.*

BYRON, CHARLES S., and MICHALOVER, SAUL. Calcinosis and scleroderma with parathyroidectomy. *Ann. Int. Med.*, Feb., 1943, 18, 225-232.

A patient showing calcinosis universalis, scleroderma and sclerodactylia and muscle atrophy is presented. Studies of the calcium metabolism revealed no abnormality. The phosphorus metabolism study revealed a tendency toward a negative balance.

Roentgenography revealed the heart and lungs to be negative. Rarefaction of both humeri was noted. There was decreased thickness of the cortex and some cystic change in the upper half of the right cortex. There was thinning of the humeroscapular articulation. All the other bones appeared normal. Calcium deposits were seen in both hands, knees, particularly the left, over the right third, fourth and fifth metatarsals and the left fifth metatarsal. Larger deposits were evident in the subcutaneous tissues of the left elbow and the left knee. The bones and joints in the region were not involved. A large deposit of calcium was seen within the abdomen.

The pathogenesis is unknown. Two theories explaining the calcium deposits are generally held. The first implies a primary alteration in calcium metabolism and the second holds that calcium is deposited in previously degenerated connective tissue. Neither theory is conclusively demonstrated.

Ramsdell recently presented 4 patients with calcinosis universalis demonstrating rapid absorption of calcium deposits with improvement in the clinical picture following parathyroidectomy and hemithyroidectomy. Consequently a

right hemithyroidectomy and parathyroidectomy was performed on this patient. The authors conclude that the operation had little influence on the clinical course and no effect on the calcium deposits.—*J. J. McCort.*

MORETZ, WILLIAM H. Malignant tumors arising from the synovial membrane with report of four cases. *Surg., Gynec. & Obst.*, Aug., 1944, 79, 125-132.

There is increasing interest in malignant tumors arising from the synovial membrane although they are uncommon. The first work of importance on this group of tumors was done, in this country, by L. W. Smith in 1927.

Nomenclature. Various names have been applied to this group of tumors including synovioma, synovial sarcoma, spindle cell sarcoma, perithelioma, villous angiofibroma, synovial sarcoendothelioma, myxosarcoma, and synovial sarcomesothelioma.

Synovial tissue is encountered in the synovial membranes of joints, serous bursae, and tendon sheaths. It is generally agreed that synovial tissue arises from mesodermal tissue. The author feels that the term "malignant synovioma" is a fitting one since it does have anatomical significance and would separate this group of tumors from the benign tumors arising in the same location.

Incidence. The occurrence of these tumors is most frequent between the ages of twenty and forty years. About half the cases occur about the knee joint. Other areas commonly involved are the elbow, ankle, foot, thigh, and palm of hand. Both sexes are equally affected.

Precipitating Factors. Trauma has been reported in an appreciable percentage of these patients as having preceded the tumor but the relationship of trauma to the tumor growth is thought to be only incidental. The growths have been reported as occurring in areas which have previously been the site of chronic bursitis or synovitis.

Symptoms. In about half of the patients, pain is a prominent symptom and in about one-third of the patients, pain is the initial symptom.

Approximately 95 per cent of the patients have a noticeable tumor mass which is frequently tender. In some cases the swelling had been present for from six to ten years before operation while in others the tumor mass had been present for only a few months. The original rate of growth is usually very slow.

Anatomy. Grossly, the tumors may be firm or

soft. Some are well circumscribed and some are not. They are usually grayish-white in cross section and very vascular.

Microscopically, these tumors are differentiated into two types. The first type apparently arises from the outer, more dense layers of the synovial tissue and is usually indistinguishable from the common fibrosarcoma. The second type seems to arise more from the inner layer of the synovial tissue and is more epithelioid in character.

Prognosis. The prognosis is very unfavorable. Death is generally due to pulmonary metastases.

Treatment. Amputation is recommended unless really wide local excision is feasible.

The author presents 4 case histories bringing the number of reported cases of malignant synovioma to 82.—*Mary Frances Vastine.*

SLAUGHTER, DANIEL P. The multiplicity of origin of malignant tumors; collective review.

Internat. Abstr. Surg., Aug., 1944, 79, 89-98.

Our increasing knowledge of the behavior of malignant tumors has steadily cut down the taboos on recognition of second primaries. Multiple skin cancers are accepted by everyone as being independent tumors and not metastases from a single focus. Other combinations of cancers may be equally clear. For instance, a patient with squamous carcinoma of the upper esophagus and colloid carcinoma of the rectum is obviously a victim of two cancers and not a subject of transcendental metaplasia. In contrast to the many clear-cut instances of multiple primaries, however, there is a large number of situations in which decision may be very difficult. Patients with carcinoma of the stomach and ovary present the problem of differentiation between independent tumors and gastric carcinoma with Krukenberg tumors. Bilateral breast cancer is another situation that may be very confusing. Since cutaneous metastases to the opposite breast, particularly in the form of carcinoma "en cuirasse," are so well known, parenchymal metastases are considered to be equally possible. Whether or not this is questionable, those patients who are first seen with simultaneous bilateral breast lesions, each resembling primary tumors, and without intervening cutaneous metastases, may be reasonably considered to present multiple primary tumors. Likewise, when a patient develops a lesion in the remaining breast from one to fifteen years after removal of the other gland

because of cancer, with no evidence of recurrence of the previous lesion, and if the second appears in all respects as a typical primary breast cancer, this second tumor should be considered a new focus of neoplastic disease, and not a cellular descendant of the first lesion. This is not to say that such tumors are unrelated, because they probably are, from the standpoint of etiology.

Discussion. It seems apparent that cancer does not arise as an isolated cellular phenomenon, but rather as an anaplastic tendency involving many cells at once. Ewing remarks that in many tumors one can demonstrate cellular change toward the "precancerous" and pre-invasive anaplastic cytological picture in areas outside of the limits of the frankly invading carcinoma. It is reasonable to assume that such areas of cellular change may occur at more widely separated points in an organ, and thus produce multiple tumors separated by areas of normal tissue.

That many neoplastic diseases are of multiple origin is fairly generally accepted. Such lesions as the lymphomas, multiple myelomas and Kaposi's disease commonly occur as multiple tumors. We have not been accustomed to think of the other, usually single, neoplastic lesions as being of this type, however. Yet the common finding of multiple skin cancers, and the listed cases of multiple tumors of the colon and breast show that even these lesions have such a tendency. It suggests that the etiological factor, whatever it may be, acts on all the tissues of one type, and may produce multiple anaplastic lesions of the mucosa of the colon, for example, or the epithelial lining of the urinary bladder. On the other hand, the multiple tumors that occur in different organs suggest a tumor diathesis in the individual, certainly a greater degree of susceptibility than can be explained away as mere coincidence or accident.

Heredity may play a part in the occurrence of these multiple tumors. Whatever the etiological background of multiple tumors may be, it seems definitely established that they occur more frequently than could be expected on the basis of chance alone.—*Mary Frances Vastine.*

DONALDSON, SAMUEL W. Medical facts that can or cannot be proved by roentgen-ray; historical review and present possibilities. *Ann. Int. Med.*, April, 1943, 18, 535-550.

Although it may be said that finished roentgen-ray films properly termed roentgenograms are

merely celluloid records and that roentgen-ray machines are merely so much metal and oil and rubber, the essential element of medical roentgenology is the physician specialist. It is he who makes the examination, who directs the technical procedures and subsequently interprets the shadows on the finished photographic film. Those physicians and laymen who regard a piece of equipment as the answer to any given technical problem are laboring under a false impression.

Every court in the land is clogged by numerous personal injury cases and the state compensation commissions are always burdened with cases awaiting a hearing. Into these courts and before the labor commissioners there is a veritable parade of clients and their attorneys armed with roentgen-ray films and accompanying them are those who are willing, *per se*, to testify to the irrefutable evidence presented by the roentgen ray, irrespective of the number or diagnostic quality of the roentgenograms. Even the best trained roentgenologist cannot be expected to arrive at a satisfactory conclusion when he is confronted with an insufficient number of roentgenograms of poor diagnostic quality. Although the courts are willing to accept properly authenticated roentgenograms in evidence as pictures they do not, it seems, ask the question, a picture of what? It should be apparent that having such a picture made and interpreted by someone qualified to do so is of the utmost importance. The author then discusses the possibilities and limitations of diagnosis by the roentgen ray. This subject is considered under the following headings according to their anatomical location: head, teeth and jaws; eye, nose and throat; chest; heart and aorta; abdomen; circulatory system; bones and joints; genitourinary system; cerebrovascular system; gastrointestinal system and miscellaneous.

The article is concluded by the prediction that, taking into consideration the rapid advances made by the roentgen ray in the past, one cannot not be optimistic about the many possibilities for diagnosis that this branch of medicine may produce in the near future. The use of the electron microscope and the development of radioactive substances by the cyclotron are expected to play an important part in this future.—*J. J. McCort.*

ROENTGEN AND RADIUM THERAPY
SOETTER, H. S. The Mackenzie Davidson lec-

ture; team work in the treatment of cancer. *Brit. J. Radiol.*, Aug., 1944, 17, 229-234.

Mackenzie Davidson was one of the great pioneers in British Radiology, his chief work being in methods of localization; he elaborated stereoscopic methods which are still fundamental in roentgen localization. The lecturer emphasizes the importance of such pioneer work and also shows the value of building on it in order to establish team work among several specialists in the fight on cancer. He himself is a surgeon and perhaps understands best the surgeon's point of view. He believes the surgeon should have the first responsibility in diagnosis and determining the extent and stage of the tumor and that he must understand clearly the possibilities and danger of its removal. So far carcinomata of the stomach and large intestine have been considered purely surgical but he describes 2 cases in which he used radium with such good results, even though they were temporary, that he thinks it may in future be possible to treat these tumors by radiation when better methods of application have been worked out. Bold surgery is also indicated in cases in which there is involvement of bone in buccal carcinoma. Two illustrative cases are described.

The choice between irradiation and surgery is more debatable in operable carcinoma of the tongue. He himself prefers surgical removal of the primary growth and irradiation of the glands. In carcinoma of the breast he prefers surgical removal and is opposed to routine irradiation after removal of an early carcinoma. The surgeon can also make a valuable contribution by providing access to closed tumors, such as those of the lower half of the esophagus. Tumors of other intrathoracic structures, such as the root of the lung may be dealt with in the same way. Full opening of the thorax, which has been made possible by intratracheal anesthesia, has great possibilities. The thorax may also be opened by longitudinal splitting of the sternum. Surgical access is also valuable in tumors of the brain. The success of the Chaoul apparatus in treating epithelioma of the lip has suggested that it might be used with equal success in other regions if they could be rendered accessible. It is not difficult for example to expose the ampulla of the rectum for treatment.

The surgeon may also have to complete a cure almost accomplished by irradiation. A remnant of tumor at the base of the tongue may

persist. An ideal exposure of the base of the tongue can be accomplished by dividing the jaw by Syme's operation.

The radiotherapist must have an exhaustive knowledge of the effect of irradiation on normal and pathological tissue. While surgeon and radiologist must depend on each other they must both depend on the physicist who made radiotherapy possible and who must be depended upon for precise measurement of dosage and accuracy in obtaining a uniform field. Analysis of the results obtained by irradiation requires mathematical knowledge of a high order. Both physicist and dentist must aid in the construction of intrabuccal moulds for the application of radium. Increased voltage is one direction of physical advance and though the expense and the space required are both great, further work must be done with the million voltages for there is no telling to what they may lead. The lecturer favors the development of apparatus capable of delivering a large dose in a short time to a tumor exposed surgically.

A biochemist is also a necessary member of the team. The destructive effect of irradiation appears to be limited to the individual cell. It is possible that some substance may be elaborated in the body itself which will destroy the cancer cells.

The team once organized should act together and the individuals composing it be able to sink their individual preferences in favor of the wellbeing of the patient. It is suggested that all cases be considered by the team and their treatment be assigned to whatever field promises the longest length of survival and the best possible condition for the patient.—*Audrey G. Morgan.*

SIMCHOWITZ, H. C. German radiotherapy in 1942-1943. *Brit. J. Radiol.*, July, 1944, 17, 216-217.

Since the beginning of the war the German publication *Strahlentherapie* has not reached England but the volumes for 1942 and 1943 have recently arrived. German radiotherapy has apparently been stagnating; there does not seem to be any advance in any particular field. Nearly all the papers with the exception of two from the Swiss Radiological Center at Zürich are rather conventional and show no familiarity with recent developments in the international literature. Most of the papers are by German and Austrian authors with a few by Hungarians and Swiss. There are none by Italians.

A brief summary of the main papers is given.

An article by Zuppinger of Zürich on "The Second Course of Protracted-Fractionated X-ray Therapy is quite interesting.—*Audrey G. Morgan.*

BUSH, F. The calculation of dosage rate in rectangular fields. *Brit. J. Radiol.*, Aug., 1944, 17, 248-250.

The dosage rate at any point in a roentgen-ray field is made up of two factors, the primary radiation and the secondary radiation, Clarkson in 1941 showed how the dosage rate due to secondary radiation can be determined by dividing the field into a number of sectors, measuring these and adding the contributions of the different sectors. In the case of rectangular fields it is possible by using the principle of his method to construct a single set of curves from which, using the central depth dose data tabulated by Mayneord and Lamerton, the secondary radiation at nearly all points, in a field of any size and for any quality of radiation and focal skin distance, can be determined without the necessity of measuring sectors. This saves time if a number of points have to be calculated, as is the case when an isodose curve is to be constructed. The mathematical data on which the calculations are based are given and curves showing the results given. The method of plotting the isodose diagram is described.—*Audrey G. Morgan.*

UNGAR, E. M., SPIEGLER, G., and SMITHERS, D. W. The volume localisation of deep-seated tumours by means of tomography. *Brit. J. Radiol.*, Aug., 1944, 17, 235-238.

Since three-dimensional distribution of radiation has come into use it is important to know the volume of the tumor to be treated and its localization in relation to the surface of the body. Tomography, or sectional roentgenography, has proved of value in the localization and determination of the volume of tumors in various parts of the body. The technique of reconstruction of tumors by means of tomography is discussed, an apparatus for measuring the depth of tomographic planes described and the method of estimating the degree of magnification in each plane considered. Illustrations are given of tumors reconstructed by placing the redrawn tomograms in their correct relative positions in space. It must be remembered, however, that the use of tomography does not make it possible to dispense with straight roentgenograms. For instance, in a tumor in-

volving the antrum, posterior ethmoids and base of the skull, the main body of the tumor may be clearly seen on tomograms, but spread to the base of the skull may be missed if straight roentgenograms are not also considered. Tomography is merely an aid to accurate tumor localization and volume determination in some parts of the body and its value rests on the interpretation of the roentgenograms.—*Audrey G. Morgan.*

MORTON, J., GRAY, L. H., and NEARY, G. J. Consideration of dose distributions in the treatment of intrinsic carcinoma of the larynx by radium implantation. *Brit. J. Radiol.*, July, 1944, 17, 204-212.

This paper describes anatomical and physical studies of types of radium implantation used at the Radium Institute, Northwood, Middlesex. Illustrations of the distribution of the needles and their relationship to the anatomical structures of the larynx are given. Two methods were used, one that of Harmer and Finzi in which one ala of the thyroid cartilage was fenestrated and the other a modification of this method in which the lower border of the thyroid cartilage and the upper part of the cricoid ring were also removed. Doses of about 6,000 r were delivered in 168 hours with about 10 mg. of radium. The necessary intensity was obtained by placing the needles very close to the growth and in this way avoiding injury to the surrounding healthy tissues. Eighteen larynges of men and women were examined by anatomical dissection to get the average position of the radium needles with reference to the anatomical structures and in this way compute the dosage. In 1 case a male larynx was halved by median section, fenestrated and the dose distribution determined directly by means of a small ionization chamber. The results of the two methods were in agreement. The uniform irradiation of the length of the vocal fold by a distribution of vertical needles is described.

With the normal fenestration technique there is almost certainly inadequate irradiation of growths which involve the posterior part of the vocal folds. It is possible that this could be obviated by the use of special unequally loaded needles.—*Audrey G. Morgan.*

HOWES, W. E., and PLATAU, M., Carcinoma of the larynx; review of treatment and end results of Brooklyn Cancer Institute. *Arch. Otolaryng.*, Aug., 1944, 40, 133-138.

The most significant prognostic factor in any case of laryngeal carcinoma appears to be the exact site of origin of the lesion. The significance of this factor seems to be due to the fact that the supporting matrix beneath the mucosal surface of the vocal cords is made up of a dense fibrous connective tissue with little or no lymph drainage while the supporting structure beneath the epithelium of the extrinsic larynx is that of a loose areolar tissue rich in a lymph supply. In most cases an epithelial new growth arising in or about the larynx is squamous cell carcinoma. It has been stated that histopathologic structure is of minor importance in determining the radiosensitivity of laryngeal carcinomas. It is therefore more the character of the framework and the richness of the lymph drainage which affect most the progress and spread of these neoplasms. As a corollary, the rapidity of growth, the manner of spread, the prognosis and the modality of treatment vary markedly with lesions which arise within a few millimeters of each other.

The cases of all patients (numbering 77) with laryngeal carcinoma who were admitted to the Brooklyn Cancer Institute from 1934 through 1942 have been reviewed.

Sex Incidence. Only 3 of the entire series of patients were females. The high incidence in males suggests some possible intrinsic etiologic factor in testicular hormone. The increased prevalence of smoking among women has not, up to the present, altered the high proportion of cases of laryngeal and bronchial carcinoma in which the patients were of the male sex.

Age Incidence. The youngest patient in the series was thirty-eight years and the oldest eighty-one years of age. The average age for the whole group was 58.5 years.

Symptomatology. The earliest symptom of laryngeal cancer is usually a "husky voice." Ulceration limited to a vocal cord may not produce pain. The first indication of carcinoma arising in the extrinsic laryngeal structures may be dysphagia. This is probably due to the carcinoma's rapid permeation of the surrounding lymphatics. Enlargement of cervical lymph nodes is common in patients who present themselves with a primary cancer arising in the vicinity of the vocal cord.

In spite of the fact that the greater number of patients gave a history of hoarseness of less than one year, most of the lesions were far advanced when first examined at the Brooklyn Cancer Institute.

Classification. Carcinoma of the intrinsic larynx usually originates on the free edge of a vocal cord. It may occasionally arise on the ventricular bands or in the interarytenoid region. It is usually of the squamous type.

Carcinoma of the extrinsic larynx originates most frequently on the epiglottis, the aryepiglottic folds or the arytenoids, within a piriform sinus or along the posterior laryngeal wall. This carcinoma is also usually squamous cell in type. It metastasizes early into the cervical lymph nodes.

Treatment. When the carcinoma is localized, operation offers the greatest opportunity for cure. Lesions too advanced for excision are usually referred for radiation therapy. All patients receiving roentgen therapy at the Brooklyn Cancer Institute have been given a modified Coutard type of repeated daily doses. Fifty-four patients received this treatment. This number included those with intrinsic lesions too extensive for surgical management and practically all the patients with extrinsic lesions inasmuch as these growths are not amenable to surgical treatment at any stage.

Analysis of Results of Roentgen Treatment. Many of the patients were admitted in such an advanced state of disease that but small palliative doses of roentgen therapy were given in the hope of reducing edema or infection. Therefore, for the study of end results it was decided to subdivide these patients into two groups: (1) those who received 4,875 r or more to the tumor in one continuous cycle of not over seven weeks' duration, and (2) those who received any dose of roentgen radiation up to 4,875 r, obviously not a carcinogenic dose. According to this postulate, 43 patients received a so-called therapeutic dose. Twenty-four of these 43 patients are listed as having a neoplasm that arose in the extrinsic larynx and 19, one that arose in the intrinsic larynx. Ten, or 23.25 per cent, of the 43 patients who received a so-called carcinogenic dose of roentgen therapy are living to date.—*Mary Frances Vastine.*

PHANEUF, LOUIS E. The management of uterine myomas; study based on 1000 consecutive personal cases and illustrating the technique of panhysterectomy. *Surg., Gynec. & Obst.*, Aug., 1944, 79, 182-191.

Uterine myomas are tumors made up of smooth muscle and connective tissue in varying proportions and enveloped by a definite capsule of condensed muscle tissue from which they de-

rive part of their blood supply. The smaller tumors which are not producing symptoms (the chief of these being hemorrhage and pressure) require no treatment. For those whose symptoms require treatment, two methods are available—surgery and irradiation. The author prefers surgery over irradiation and discusses the surgical aspect of treatment in some detail. In his discussion of irradiation, he observes that radium is superior to roentgen rays because only one treatment is usually necessary. Also, in treatment with radium, the radioactive substance is applied directly in the uterine canal so that the necessity of the rays traversing the abdominal wall in order to reach the uterus and ovaries is obviated. (He does not give the objections to the rays traversing the abdominal wall to reach the ovaries and uterus.)

The commonly accepted dose of radium for uterine myomas varies between 1,500 and 2,400 milligram-hours.

It should be an inviolate rule that a diagnostic curettage to rule out a malignant neoplasm of the endometrium must precede either method of irradiation. Certain classes of tumors constitute definite contraindications to this form of therapy, viz.,

1. Tumors larger than a three months' gestation.
2. Rapidly growing tumors suggesting progressive changes.
3. Tumors producing pressure symptoms.
4. Tumors associated with pelvic pain.
5. Pedunculated tumors in which irradiation tends to increase necrosis.
6. Tumors associated with adnexal pathology.
7. Tumors associated with cachexia.
8. Tumors in young women.
9. Multiple submucous tumors.
10. Tumors associated with pyometria.—

Mary Frances Vastine.

RASHBAUM, MAURICE, and McINTOSH, HARRIET C. Pelvic actinomycosis treated by surgery and roentgen ray, with recovery. *Am. J. Obst. & Gynec.*, June, 1944, 47, 849-854.

Actinomycotic infection of the internal genitalia of the female is uncommon and recovery is rare. Eighty-five cases of actinomycosis of the female pelvic organs have thus far been reported, of whom only 7 have survived. The authors report an additional case apparently cured of this malignant disease. Of the 7 cured cases already reported, 5 were treated by

surgery and roentgen irradiation, 1 by surgery and potassium iodide, and 1 by surgery, potassium iodide, roentgen and radium irradiation.

Summary of Case Report.

1. The clinical picture presented by this patient before operation was one of protracted, severe pelvic suppuration, with septic temperature, severe secondary anemia, and emaciation. Posterior colpotomy was performed on four occasions for the drainage of pus collections in the pelvis, with only temporary benefit.

2. Laparotomy was performed six and a half months after admission to the hospital, although the blood sedimentation rate was still very rapid. At operation, the findings resembled those commonly seen in cases of recurrent pelvic suppuration with tubo-ovarian abscesses.

3. In spite of hysterectomy and bilateral salpingo-oophorectomy, followed by large doses of potassium iodide, there was prompt recurrence in the abdomen. Roentgen treatment resulted in disappearance of the recurrences. The method employed, namely, surgery, followed by fractional roentgen treatment with high total dosage, is probably the most effective in the treatment of abdominal actinomycosis.

4. Follow-up examination, five and ten years later, disclosed that the patient was well and there was no evidence of abdominal or pelvic disease.—*Mary Frances Vastine.*

MISCELLANEOUS

ROBERTS, G. L. Observations on radiolucency as a significant physical property of the acrylic dental materials. *Brit. J. Radiol.*, July, 1944, 17, 218-220.

Until comparatively recently vulcanite and metal have been the standard materials for making dental appliances. These were radiopaque. But recently dental materials of the methyl methacrylate type of plastics have been introduced for this purpose and their use rendered necessary by the withdrawal of rubber as a dental commodity. From the dental point of view this is an advantage as the technical methods of using these acrylic materials are simpler, they have a wider range of use than those formerly in use and the cosmetic results are better.

But from the point of view of the radiologist they have the disadvantage that they are radiolucent and show practically no shadow on the roentgenogram. In case of broken dentures and

the presence of fragments in the body the roentgenologist should make sure of not giving a false negative report by familiarizing himself with the naked eye appearance of these materials and by questioning the patient's dentist as to whether the dentures were made of acrylic material and whether they included any porcelain teeth or metal bands which would show in the roentgenogram.

The radiolucency of this material is an advantage when it is used for the making of splints in jaw fractures. The old materials obscured parts lying beneath them and had to be removed in making a roentgen examination, but these can be left in place and a clear image obtained.—*Audrey G. Morgan.*

HASTINGS, W. H. Localisation of foreign bodies by a radiometric method. *Brit. J. Radiol.*, Oct., 1944, 17, 316-318.

A roentgen method for determining the depth of foreign bodies is described which is absolutely accurate, does not require fluoroscopic examination and is quickly and easily carried out. The approximate localization of the foreign body is determined by a roentgenogram and a pin strapped to the surface of the skin above it. The tube is centered over the head of the pin, the focus of the tube being at a height of exactly 30 inches (76 cm.) above the film which is placed beneath the part. Two exposures are then made, one at a distance of $1\frac{1}{2}$ inches on one side of the pin and the other $1\frac{1}{2}$ inches on the other side, the total tube shift being 3 inches. These distances must be kept very accurately if the table of correction factors which is given is to be used.

Two diagrams and a roentgenogram are given which illustrate the application of the method. Only a minimum amount of calculation is required.—*Audrey G. Morgan.*

MEDLER, E. M., PESQUERA, G. S., and ORDWAY, W. H. A comparison of roentgenograms with the pathology of experimental miliary pulmonary tuberculosis in the rabbit. *Am. Rev. Tuberc.*, July, 1944, 50, 1-23.

Thoracic roentgenograms are indispensable in the study of pulmonary tuberculosis in man, particularly in the minimal stage of the disease and in the demonstration of lesion instability. Nevertheless, the limitations of the roentgenologic method must be understood. The chief concern to date has been the development of

apparatus and roentgenographic technique to yield comparable roentgenograms demonstrating the best film qualities. In order to circumvent the interference by denser thoracic structures, stereoroentgenograms, oblique, lateral and lordotic positions, spot films, fluoroscopy, and planigraphy have been utilized.

That tuberculous foci may exist in the lungs and not be visualized on satisfactory roentgenograms has not been appreciated generally. The authors have been unable to find reports in the literature of studies on man comparing chest roentgenograms with films of excised, inflated lungs and with the necropsy findings. A comparative study of the pathological findings and of roentgenograms of the thorax and of inflated excised lungs in experimentally produced miliary pulmonary tuberculosis in the rabbit is presented. Primary infection following inoculation with virulent and non-virulent bovine tubercle bacilli and re-infection with virulent bacilli in animals previously vaccinated with non-virulent organisms were studied.

The results revealed that the greatest numbers of lesions, as well as their essential pathology, were demonstrated on microscopic study; and, otherwise, macroscopic examination, roentgenograms of excised and inflated lungs and, lastly, thoracic roentgenograms were capable of demonstrating the pathological findings to a lesser degree and in the sequence mentioned.

By roentgen shadows alone, dense caseous, non-caseous, caseofibrotic and fibrotic areas could not be differentiated in the excised inflated lungs. Compact deposits of calcium were clearly demonstrable in caseous foci, but with lesser deposits, no differentiation between caseous material and calcium was possible. Likewise, superimposition of lesions produced a density on the roentgenogram which gave a false idea as to their size and nature; moreover, compactness, rather than size, is the most important factor governing the shadow characteristics. It seems that the compact portion of a lesion must be equal to the volume of a primary parenchymal lobule before a shadow will be cast on films of excised lungs. Actually, foci, when first observed in roentgenograms of the thorax are, in reality, considerably larger than the roentgen shadow would indicate because the loosely arranged peripheral inflammatory tissue is not radiopaque.

The authors suggest that it would be better practice if interpretations of intrathoracic shadows observed in chest roentgenograms were

limited to descriptions of location, distribution and density. Pathologic interpretations, i.e., "fibrotic," "caseous," "productive," "exudated," etc., should be avoided.—*John R. Hannan.*

BEAMS, A. T., FREE, A. H., and LEONARDS, J. R. Experimental hypoproteinemia and edema; studies of intestinal absorption and intestinal roentgenologic characteristics. *Arch. Int. Med.*, May, 1944, 73, 397-402.

Using adult, female, mongrel dogs the authors produced hypoproteinemia with edema in 5 of the dogs by plasmapheresis. This procedure was repeated daily until the plasma proteins were depleted to a suitable level (2 to 3 gm. per 100 cu. cm.) and a definite edema could be demonstrated. The intestinal absorption of galactose and amino-acetic acid was studied by means of improved tolerance tests. This was done by the oral administration of the test substance by a stomach tube followed by the determination of the concentration of the substance in the blood after definite intervals of time. The type of curve obtained is an indicator of the degree of intestinal absorption. Since the blood concentrations are also affected by the rate of metabolism this is given consideration in the method. The presence of hypoproteinemia and edema had no significant effect on the rate of intestinal absorption of galactose and aminoacetic acid in this experiment.

Roentgenologic observations of the gastrointestinal tract were made after the oral administration of barium sulfate. Gastric emptying and intestinal motility were not altered by hypoproteinemia and edema. Some of the roentgenograms of the small intestine during edema showed moderate clumping of the barium and fragmentation. These phenomena were also noted in the studies on normal animals, although they occurred less frequently.—*J. J. McCort.*

SIMENDINGER, E. A. Thyroid function as a factor in gall-bladder disease and formation of gall stones. *Surg., Gynec. & Obst.*, July, 1944, 79, 10-20.

This study of gallbladder disease was undertaken to attack the problem as one of both a local and systemic nature, associated with a disease which affects the body function generally, namely, hypothyroidism. Numerous authors have shown that mild degrees of hypothyroid-

ism are frequently associated with gastrointestinal symptoms commonly seen in cholecystitis. J. W. Hinton reviewed 43 cases of hypothyroidism which presented the typical symptoms of peptic ulcer. Riegel, Ravdin, and Morrison noted that thyroid disorders are frequently associated with gallbladder disease.

It is of more than passing interest that all gallstones contain cholesterol. A high blood cholesterol level is found in both gallbladder disease and hypothyroidism. In fact, many authors believe that the blood cholesterol level is a more accurate index of thyroid function than the basal metabolic rate. Both hypothyroidism and cholecystitis are much more common in females and both diseases are associated with obesity.

In the author's clinic 36 per cent of patients with chronic gallbladder disease showed basal metabolic rates of -10 per cent or below, and an additional 40 per cent showed a basal metabolic rate from 0 to -10 per cent. Only 24 per cent showed a positive metabolic rate. The author believes that these figures show that there is a definite trend toward hypothyroidism in the patients with chronic gallbladder disease.

Results of Experimental Studies.

1. A sustained elevation of the blood cholesterol occurred in thyroidectomized dogs, appearing about twenty-seven to thirty days following operation.

2. A prolonged high blood cholesterol level (two months or more) resulted in no increase in cholesterol output in the hepatic bile.

3. The hepatic bile salt content and total biliary output were somewhat low in these thyroidectomized animals as compared to the normal.

4. Gallbladder bile aspirated from the gallbladders of hypothyroid dogs showed a normal bile salt and cholesterol content in spite of the fact that an elevated blood cholesterol existed.

5. Gallbladder walls in hypothyroid dogs were studied microscopically and clinically for cholesterol deposit within them and no significant difference from the normal was found.

6. When the abdomens of the hypothyroid animals were first opened, the gallbladders of almost all the hypothyroid animals were greatly distended and contained much thick brown precipitate.

7. Several dogs were thyroidectomized and cholecystograms were made. The gallbladders of the experimental animals either failed to visualize, or, after visualization, showed a prolonged emptying time as compared to the normal.

Conclusions.

1. The hypothyroid state does materially affect gallbladder function. The large quantity of debris and concretions found, plus the roentgen findings, indicate that a marked degree of stasis takes place within the gallbladder.

2. Apparently a high blood cholesterol, as indicated by the hypothyroid state, does not result in an increase in the cholesterol content of the hepatic bile, nor does it result in a deposit of cholesterol within the gallbladder walls.

3. Obviously, infection plays a major part in the production of cholecystitis and cholelithiasis. However, any constitutional disease which impairs gallbladder function would certainly render the organ more liable to bacterial invasion and would be a factor to consider in the ultimate production of chronic cholecystitis.

4. Heavy precipitate and pigment concretions as seen in these hypothyroid dogs might easily be nuclei about which stones might form if infection were superimposed upon the condition already present. In view of this, the hypothyroid state merits consideration as a contributing cause of cholecystitis and cholelithiasis and should be borne in mind when these patients are seen. — *Mary Frances Fastine.*





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OPTOCHIASMATIC ARACHNOIDITIS*

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CHIASMAL inflammatory lesions produce a syndrome that is similar to that produced by a tumor in the region of the optic chiasm. If suspected, the lesions can be recognized readily by abnormal changes in the cisternae chiasmatis and interpeduncularis after the procedure of air encephalography. Yet, in 1943, Ryan²⁰ wrote, "there are still too few ophthalmologists who recognize the importance of the disease, its dire consequences to vision if not diagnosed or suspected, and the excellent results that may be obtained by surgical intervention." Ryan²⁰ and Lillie¹⁶ have stressed the importance of encephalography in making the diagnosis. Although it is well known that the chiasmal region may be involved in generalized arachnoiditis and basal gummatous meningitis, radiologic literature contains very little concerning optochiasmatic arachnoiditis, otherwise described as "chronic cisternal arachnoiditis," "chronic local arachnoiditis," and "chronic circumscribed arachnoiditis of the optic chiasm."

In 1893 Quinke¹⁵ presented generalized arachnoiditis as an entity. A few years later (1898) Schlesinger²² described localized arachnoiditis. Spiller, Musser and

Martin²³ in 1903 reported complete cure after operation on a case with a localized spinal arachnoid cyst. In 1929 Balado and Satanowsky¹ reported a case of optochiasmatic arachnoiditis as a surgical entity, with improvement following operation. Holmes¹² presented 2 cases the same year. In 1937, thirty-seven per cent of 129 reported cases had shown improvement following operation.² Others showed no further progression of signs and symptoms. Improvement is less likely in those cases with extensive optic atrophy or intrinsic involvement of the optic nerves by the disease process.

No single cause has been ascribed to optochiasmatic arachnoiditis. Trauma^{7,13,14} and infection of the meninges and brain by syphilis,^{8,25} mastoiditis,³ sinusitis,^{11,27} petrositis,³ and chronic rhinopharyngitis² have been described as etiologic factors. Bourgeois, *et al.*,³ believe it may be a sequel of encephalitis, multiple sclerosis, or tuberculosis. It has been described coexisting with Leber's disease¹⁰ and hydatid cyst.¹² In many cases the etiology is never determined. Lillie¹⁷ believes the nonspecific type described by him to be purely inflammatory in nature, chronic in form, with its portal of

* From the Department of Radiology of the Hospital of the University of Pennsylvania, Philadelphia, Pa. Presented before the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24-29, 1944.



A



B



C



D



E



F

FIG. 1, A, B, C, D, E and F. In (A) and (B) arachnoid adhesions are shown involving the dorsum sellae, optic nerves and chiasm, olfactory nerves, and adjacent brain. In (C) there are arachnoid adhesions with ependymal plaques. The adhesions have been removed in (D) revealing compression of the right optic nerve and increased vascularity. Types with multiple and single cyst formation are illustrated in (E) and (F). (Modified from "Les arachnoidites opto-chiasmatiques" by Bollack, David and Puech, Paris, 1937.)

entry perhaps through the cribriform plate in the anterior fossa.

At operation the arachnoid is thickened, grayish, and opalescent instead of transparent.¹¹ The cisterna chiasmatis may or may not be distended with cerebrospinal fluid. There may be single or multiple arachnoid cysts² and the optic nerves and chiasm appear atrophic and are usually enmeshed in adhesions.^{2,4,7} Bollack, David and Puech² also described calcareous arachnoid plaques and increased vascularity with venous distention (Fig. 1). The adhesions fix the chiasm and nerves to the base of skull, dura, diaphragm of the hypophysis, adjacent nerves and, more important, adjacent vessels, some of which are pulsating arteries.

Lillie¹⁶ divides the prechiasmal and chiasmal inflammatory lesions, which produce a syndrome suggestive of tumor, into two groups: (1) basal gummatous meningitis and (2) chronic local arachnoiditis. The former is more easily diagnosed with the aid of blood serology and spinal fluid studies which are usually negative in chronic local arachnoiditis. However, the clinical diagnosis of chronic local arachnoiditis is difficult and for this reason the rôle of the roentgenologist is an important one. The patient usually complains only of loss of vision in one or both eyes and headache which is not characteristic but frequently is bifrontal.²⁰ Rarely there may be signs of pituitary involvement or paralysis of adjacent cranial nerves.

Ophthalmoscopically the fundi may be normal²⁰ but more often there is optic nerve atrophy. Ten per cent of these patients have choked disks.² One of our cases and 2 of Hausman's had choked disks without a significant increase in intracranial pressure.⁹ Any type of visual field defect or defects may occur in one or both eyes.²⁰ Central scotoma, concentric contraction, and temporal loss are the most common observations.²

Bollack, David and Puech² classify the purely ocular symptomatic forms into three groups: (1) the syndrome of axial neuritis

(25 per cent); (2) the syndrome of simple atrophy (13 per cent); (3) the chiasmal syndrome (15 per cent). The remaining 47 per cent have atypical ocular lesions or involvement of adjacent structures of the brain. The chiasmal syndrome alone, i.e. primary optic atrophy with bitemporal field defects, may, according to Hausman,⁸ be produced by: (1) suprasellar cysts or tumors; (2) tumor, syphilis¹⁵ and hemorrhage into the pituitary body; (3) parasellar lesions such as chronic cisternal arachnoiditis, aneurysms, tumors of the optic chiasm, optic nerve, olfactory groove or sphenoid ridge, trauma of the chiasm, oxycephaly, and heredodegeneration (Leber's disease). Other entities to be ruled out include third ventricle and posterior fossa tumors,²⁶ multiple sclerosis, neuro-myelitis optica, encephalitis, retrobulbar neuritis, toxic amblyopia, and syphilitic optic atrophy without arachnoiditis.

The patient in the past usually has been referred to the roentgenologist by the ophthalmologist, neurologist, or neurosurgeon to demonstrate evidence of a brain tumor. Conventional roentgenograms of the skull and optic canals of patients who do not have brain tumors or increased intracranial pressure, but who do have ocular signs or symptoms of optochiasmatic arachnoiditis usually show nothing abnormal. There may be evidence of sinusitis which can be significant etiologically.²¹

If the conventional roentgen examination shows nothing abnormal in such patients, it is important for the roentgenologist to emphasize the possibilities of air encephalography. Lillie¹⁶ has reported 3 cases in which the correct pathologic process was predicted after air encephalography. We have observed the conditions several times, our first proved case being in October, 1935.

Before discussing the encephalographic changes in the region of the diseased optic chiasm, we shall review the normal appearance of this region. The arachnoid and pia mater membranes covering the spinal cord, the brain, the hypophysis and the intracranial nerves are generally in close ap-

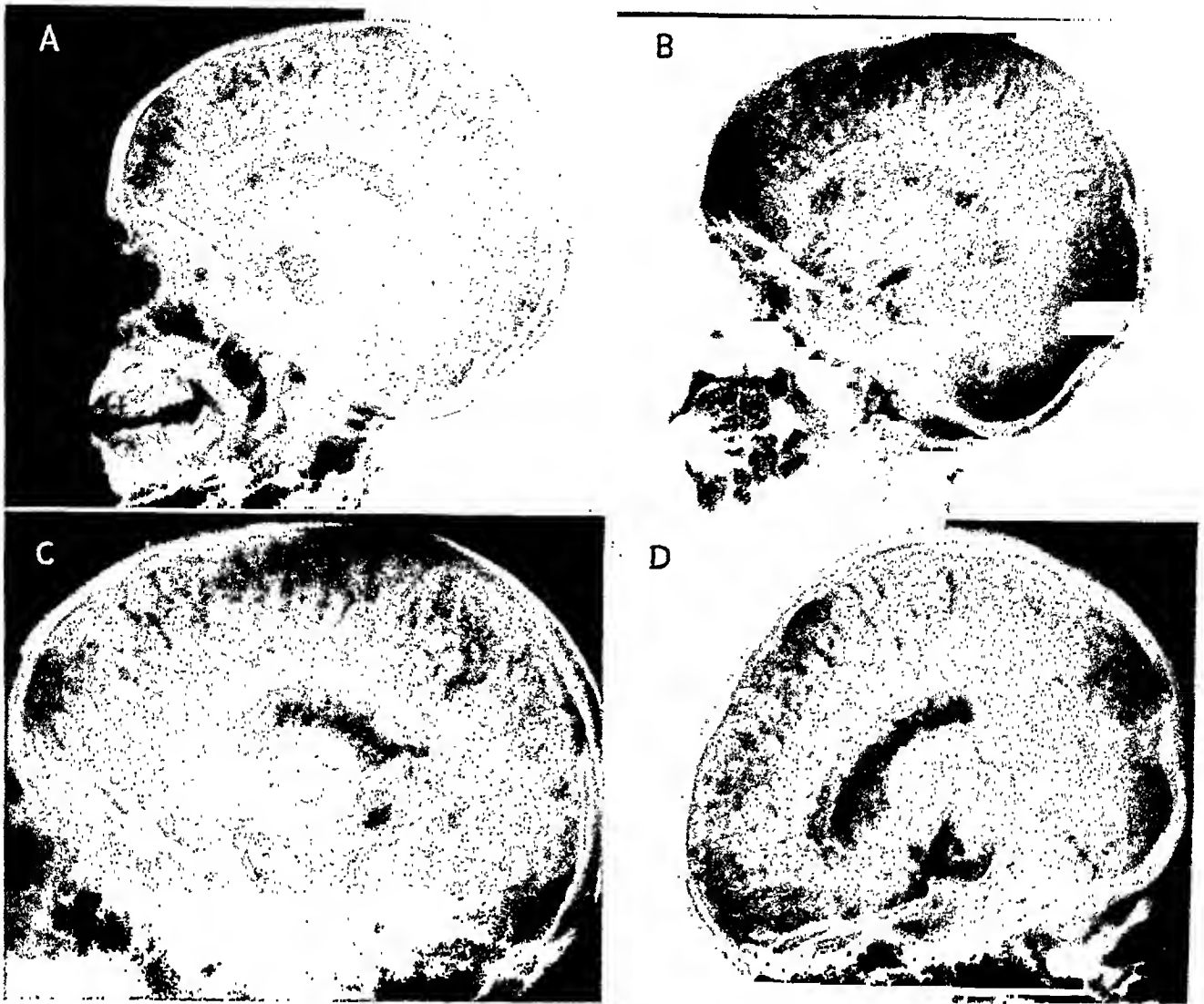


FIG. 2, *A*, *B*, *C* and *D*. Encephalogram illustrating appearance of the cisternae chiasmatis, interpeduncularis and pontis in the erect lateral position (*A*), in the horizontal lateral position (*B*), and in the prone (*C*) and supine (*D*) positions. In illustrations (*A*) and (*D*) the cisternae shadows around the hypophyses are seen better than in (*B*) and (*C*).

position with the dura mater except over the cerebral sulci and the cisternae at the base of the brain. The cisternae are formed by a wide separation of the arachnoid and pia mater. Encephalographic procedures may outline the cisternae magna, chiasmatis, interpeduncularis, pontis, lamina terminalis, ambiens, fossae of Sylvius, and the corpora callosi.

In this presentation we are concerned most with the chiasmatis, interpeduncularis, and pontis. In the so-called normal encephalogram there is some variation in the size and shape of these cisternae depending largely upon the position of the optic chiasm, the neighboring structures and the conformation of the base of the

skull and the position in which the roentgenograms are made. For instance, if the lateral roentgenograms are made in the erect posture, one may see the shadows of the basal cisternae around the hypophysis and their contained structures, whereas if the roentgenograms are made with a vertical beam in the horizontal posture the contained structures in the cisterna chiasmatis may be entirely or incompletely obscured (Fig. 2*B*). If one uses a horizontal beam to make lateral roentgenograms of the head with the patient lying first on the abdomen and then on the back, one observes that the air in the cisternae around the hypophyses changes position with change in posture and oftentimes provides

an opportunity for obtaining additional information to that secured in the erect roentgenograms (Fig. 2, *C* and *D*).

Most of the cisterna chiasmatis lies between the diverging optic nerves. It extends laterally as far as the carotid arteries, communicating ventrally with the

cerebral artery may be outlined in the superior portion of the cisterna chiasmatis (Fig. 4). Beneath and posterior to the anterior communicating artery, about 1 cm. above the sella turcica is a 3-4 mm. ovoid shadow representing the optic chiasm. The position of the optic chiasm is

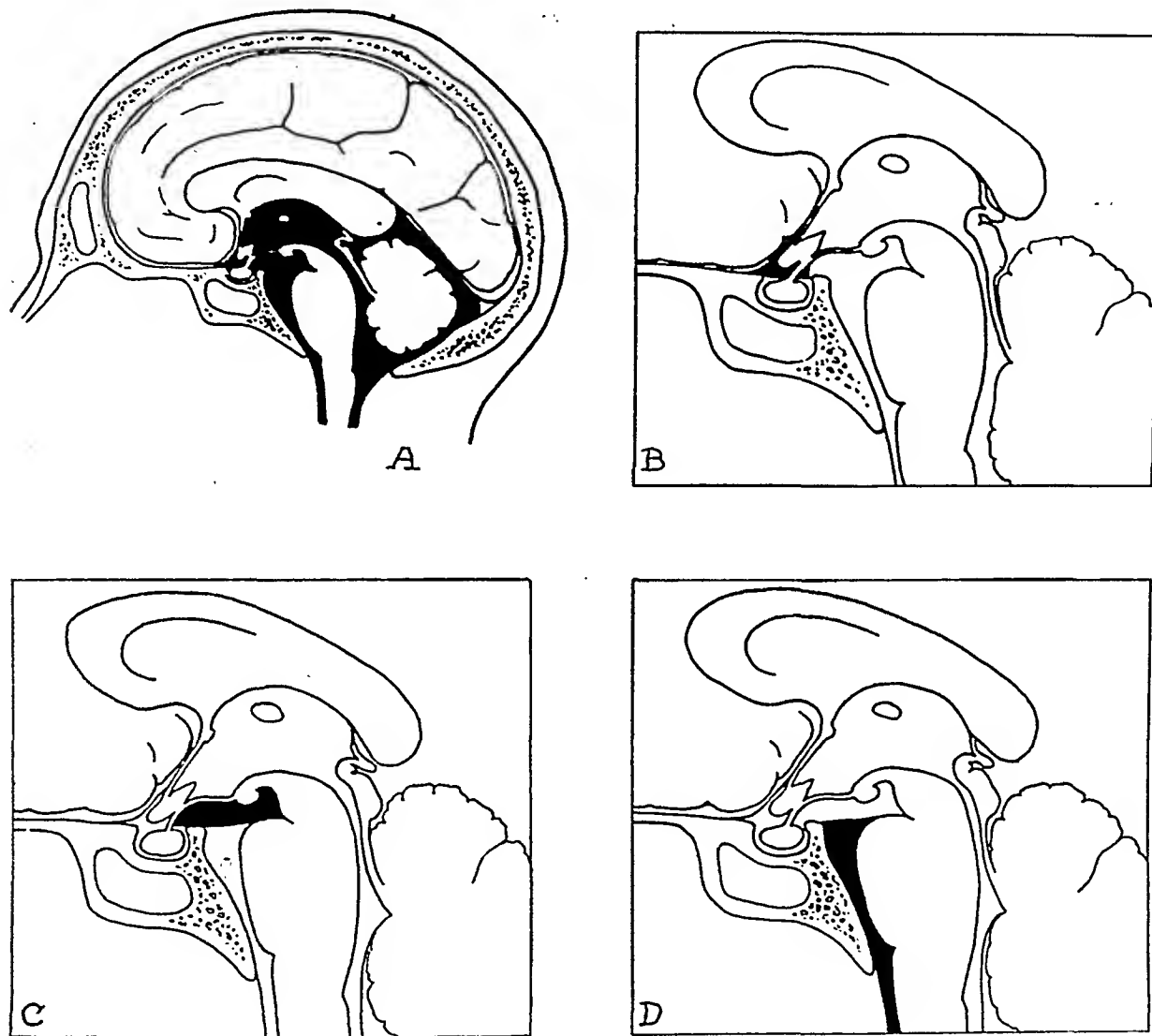


FIG. 3, *A*, *B*, *C* and *D*. Schematic drawing of the basal cisternae (*A*), including the cisternae chiasmatis (*B*), interpeduncularis (*C*), and pontis (*D*).

hypophyseal subarachnoid space and with the cisterna interpeduncularis posteriorly beneath the optic chiasm (Fig. 3). That portion of the cistern anterior to the chiasm is usually visualized, while the lateral extensions around the optic nerves are less frequently seen.⁶ The anterior communicating artery and occasionally the middle

quite variable. Schaeffer²¹ states that in his study 5 per cent were located anteriorly on the chiasmatic sulcus, the remaining portion resting upon the diaphragma sellae. Twelve per cent were wholly located over the diaphragma sellae, while in 79 per cent the optic chiasm was almost completely over the diaphragma sellae, a small portion

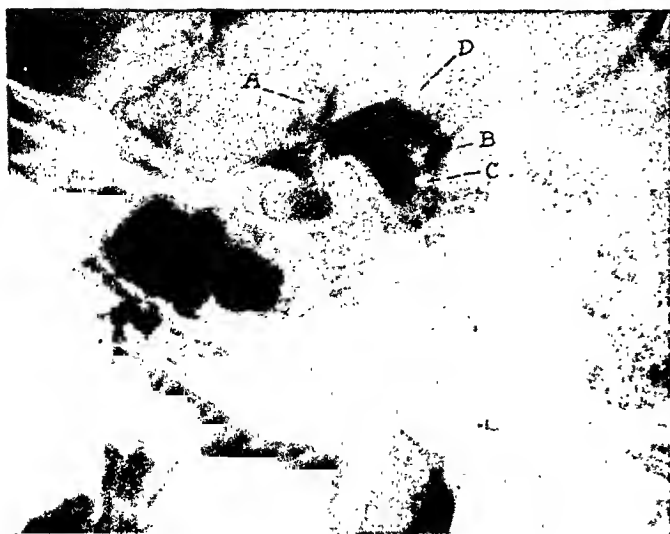


FIG. 4. The shadows of the anterior communicating artery can be seen at (A), the posterior cerebral artery at (B), the superior cerebellar at (C), and the mammillary bodies at (D).

projecting on to the dorsum sellae. In 4 per cent, the chiasm was located on and posterior to the dorsum sellae. The optic nerves can be seen extending obliquely downward and forward across the cisterna (Fig. 5). The infundibulum of the hypophysis is more posterior, running at a sharper angle forward and downward to the diaphragma sella (Fig. 6). Above the diaphragma sella the chiasmatis communicates with the cisterna interpeduncularis.



FIG. 5. The shadows of the optic chiasm and nerves can be seen at (A). The basilar and posterior cerebral arteries are seen at (B) and (C), respectively.

In the lateral view, the cisterna interpeduncularis is limited anteriorly by the infundibulum, optic chiasm, and tuber cinereum. The posterior border is formed by the pons, and the cerebral peduncles

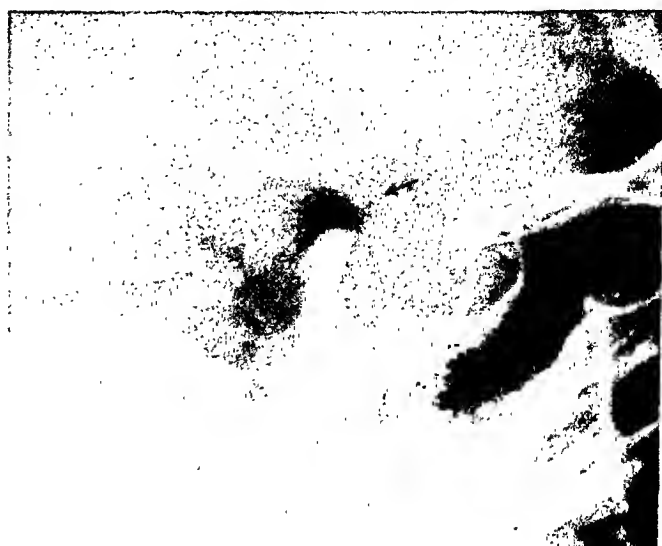


FIG. 6. A case of basal arachnoiditis in which the thickened arachnoid accentuates the outline of the infundibulum.

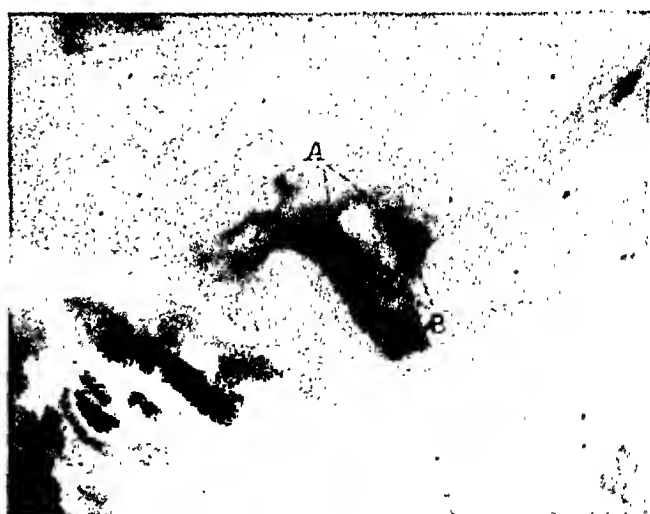


FIG. 7. Shadows which may represent the oculomotor nerves or vascular structures can be seen at (A) and (B).

limit the cisterna above and somewhat posteriorly. A portion of the diaphragma sellae, the dorsum sellae, and the cisterna pontis limit the interpeduncularis below. Anteriorly and below the peduncles, the corpora mammillaria project into the cisterna. This shadow is round and 4-5 mm. in diameter. The tuber cinereum is

seen as a straight line slanting down from the corpora mammillaria to the optic chiasm (Fig. 4). The oculomotor nerves run in the lateral walls of the cistern and occasionally may be seen running forward and slightly downward across the cistern, disappearing behind the sella (Fig. 7). In the posterior portion of the cistern the posterior cerebral arteries may also be visualized as they branch from the basilar. Beneath this the superior cerebellar arteries can be seen (Fig. 4).

Beneath and in direct communication with the cisterna interpeduncularis the cisterna pontis is bounded by the dorsum sellae and pons (Fig. 3). The most readily visible structure within it is the basilar artery (Fig. 8). The trigeminal, abducens, facial, and acoustic nerves cross the cisterna but are not readily visible.

One cannot be dogmatic in his interpretation of the structures seen in the above described cisternae, for there are several shadows, often visible, which have not been included in classical descriptions of the structures seen in these cisternae after encephalography. The internal carotid artery is often described when calcified but is otherwise not mentioned. In the "normal" encephalogram there is occasionally a curvilinear shadow posterior to and merging with the dorsum sellae (Fig. 9*A*).

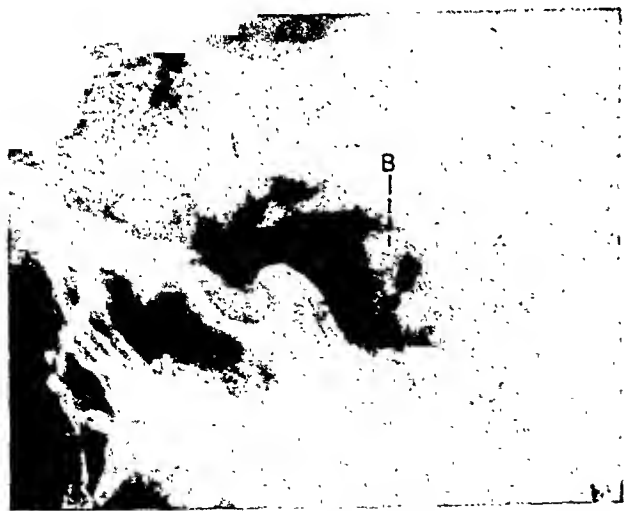


FIG. 8. The shadow of the basilar artery is well visualized at (A) and the posterior cerebral artery at (B).

This shadow cannot be seen on the plain roentgenograms (Fig. 9*B*) but comparison with an arteriogram in the same patients

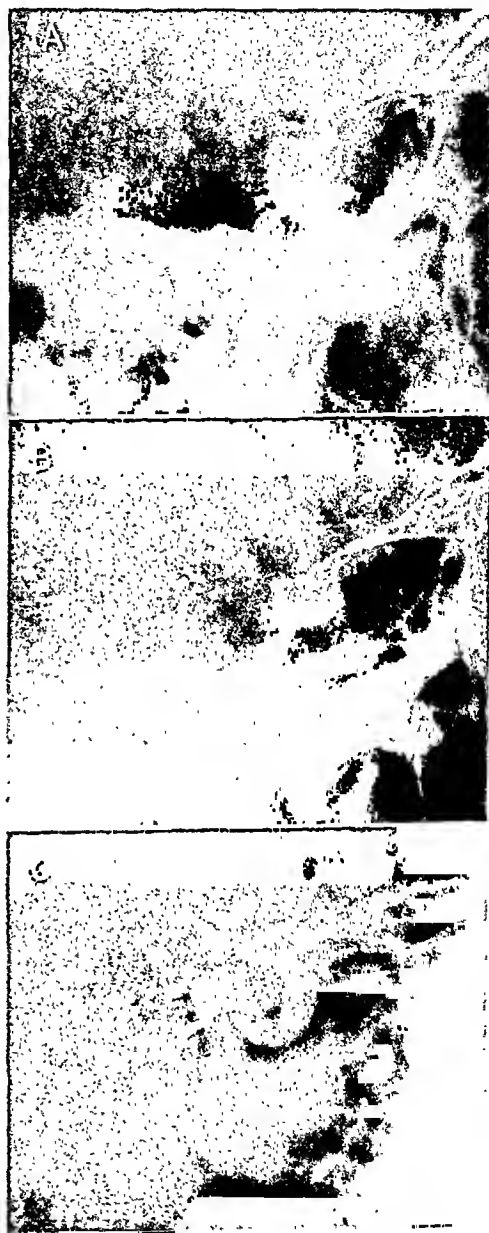


FIG. 9. A, B and C. The shadow of the internal carotid can be seen in the encephalogram (A). It is not visible in the plain roentgenogram (B). The arteriogram (C) verifies its position in relation to the sella.

(Fig. 9C) lead us to believe the shadow is the internal carotid artery which ascends towards the posterior clinoid processes, curves forward before reaching them, pierces the external layer of the dura mater,

and enters the outer wall of the cavernous sinus. It continues forward in the sinus as far as the anterior clinoid processes and tuberculum sellae. At that point it bends upward through the inner layer of the dura. It then passes backward forming a U-shaped

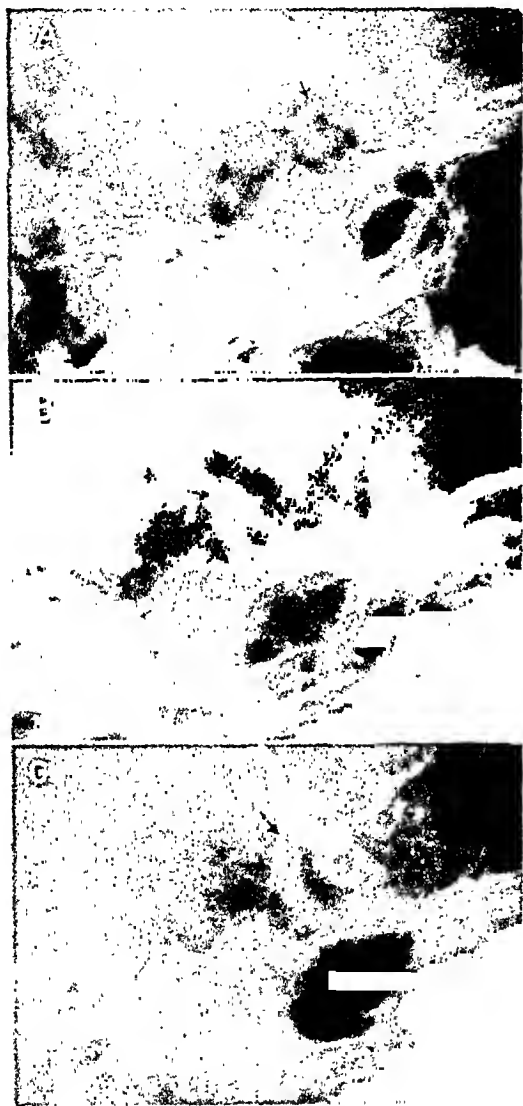


FIG. 10, *A*, *B* and *C*. The internal carotid is well visualized in (*A*) and (*B*). An arteriogram (*C*) verifies the position of the shadow seen in (*B*).

curve, "le siphon carotidien," and pierces the arachnoid to divide into its terminal branches, the anterior and middle cerebral arteries. Examination of normal encephalograms reveals an undescribed shadow ascending obliquely across the cisternae chiasmatis and interpeduncularis (Fig. 10). An arteriogram performed on one of these patients (Fig. 10*C*) reveals this shadow to

be coincident with the upper arm of "le siphon carotidien" or U-shaped curve of the internal carotid artery. This shadow may be confused with the infundibulum (Fig. 6) but is more anterior and much larger. Less often it may be confused with the optic chiasm and nerves. One must also distinguish it from adhesions such as will be described below in cases of optochiasmatic arachnoiditis.

The encephalographic findings in optochiasmatic arachnoiditis are rather typical, if the cerebrospinal system is well drained of fluid and replaced with air through the lumbar route. When the cisternal route is employed the basal cisternae are not seen well in the encephalogram. The shadows of the cisternae chiasmatis and interpeduncularis can be readily demonstrated in most individuals who have no symptoms referable to that region. In the presence of optochiasmatic arachnoiditis the clear air shadows of the cisterna chiasmatis, occasionally the cisternae interpeduncularis and pontis, are absent, deformed or encroached upon, and the structures usually seen within the cisternae cannot be identified. The neuroroentgenologist is likely to describe the appearance as due to a tumor. There is ample justification for such a diagnosis because, for the most part, we have not suspected that localized areas of arachnoiditis were likely to occur there and were capable of producing a syndrome similar to that produced by a tumor. We now know that such an appearance may be produced by a localized chiasmal arachnoiditis, and should be considered always in arriving at the final diagnosis.

REPORT OF CASES

Only significant findings are included in the following case summaries.

CASE 1. The patient was a single, white male, aged twenty, dental laboratory worker, admitted September 25, 1935, with a chief complaint of loss of vision for eight months. Past history revealed occupational exposure to small amount of nitric acid, lead, zinc, gold, silver, and acetone. His present illness began one year previ-

ous to admission with diarrhea of three months' duration, which was followed by an attack of chills and slight fever, diagnosed "influenza" and sinusitis. Six days later he developed generalized shaking and numbness lasting one

along the optic nerves and extending over the anterior surface of the chiasm. These were carefully separated giving a good exposure of the entire region which contained no evidence of a mass lesion. The optic nerves and internal carot-

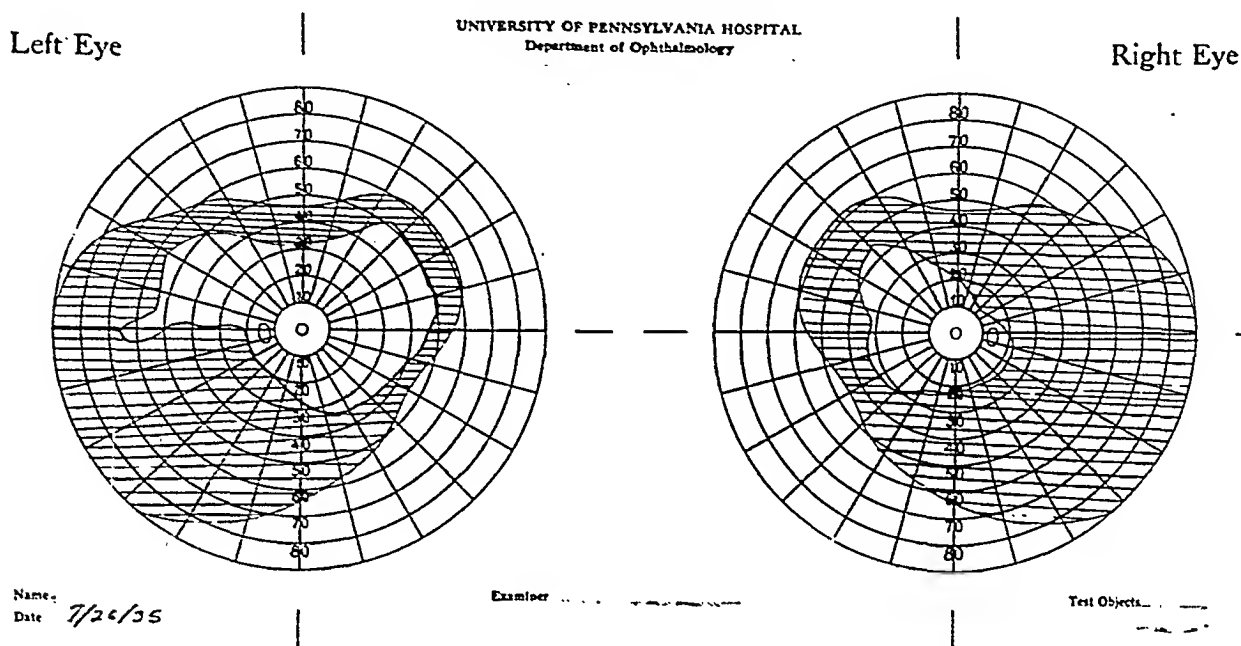


FIG. 11. Case 1. Visual fields showing bitemporal hemianopsia and contraction of the nasal fields.

month, at the end of which he lost the vision of his right eye. One month later he suffered an attack of numbness of his lower legs lasting two weeks and the vision of his left eye slowly decreased.

Physical examination revealed the liver and spleen to be palpable with deep inspiration. There was bilateral loss of vision, his visual acuity being 1/60 in the right eye and 6/60 in the left. Bilateral optic atrophy with contraction of the nasal fields and bitemporal hemianopsia (Fig. 11), and hyperesthesia of the third portion of right trigeminal nerve were also noted.

Laboratory studies including the blood Wassermann and spinal fluid were negative. Sinus roentgenograms showed mucous membrane thickening, most marked in the ethmoids. An air encephalogram revealed lack of visualization of the cisterna chiasmatis, the left ventricle was slightly larger than the right, and the cortical markings of the left cerebral hemisphere were less prominent than those on the right (Fig. 12).

A right transfrontal craniotomy was subsequently performed on October 15, 1935, and a number of firm arachnoid adhesions were found

id arteries were in unusually close contact.

On July 22, 1936, the patient's visual acuity and visual fields remained about the same or very slightly better. He was advised to enter the hospital for an encephalogram and possibly an-



FIG. 12. Case 1. The cisterna chiasmatis and upper portion of the cisterna interpeduncularis are obscured.

other operation. His vision changed little during the next few years. He returned again January 19, 1944, because his Selective Service Board would not believe he was blind and was about to induct him into the Army. He was last seen June 21, 1944, stating he had become completely blind four days before. He was extremely tense and nervous. Neurological examination was completely negative, although he had noted occasional difficulty starting his

contact with the carotid arteries, suggesting a possible mechanism for some of the optic nerve changes.

CASE II. The patient was a white male aviator, aged forty, married, admitted on March 9, 1940, complaining of loss of visual acuity for one and a half years. Eighteen months before admission he noticed dimness of vision in his left eye which cleared after several months'

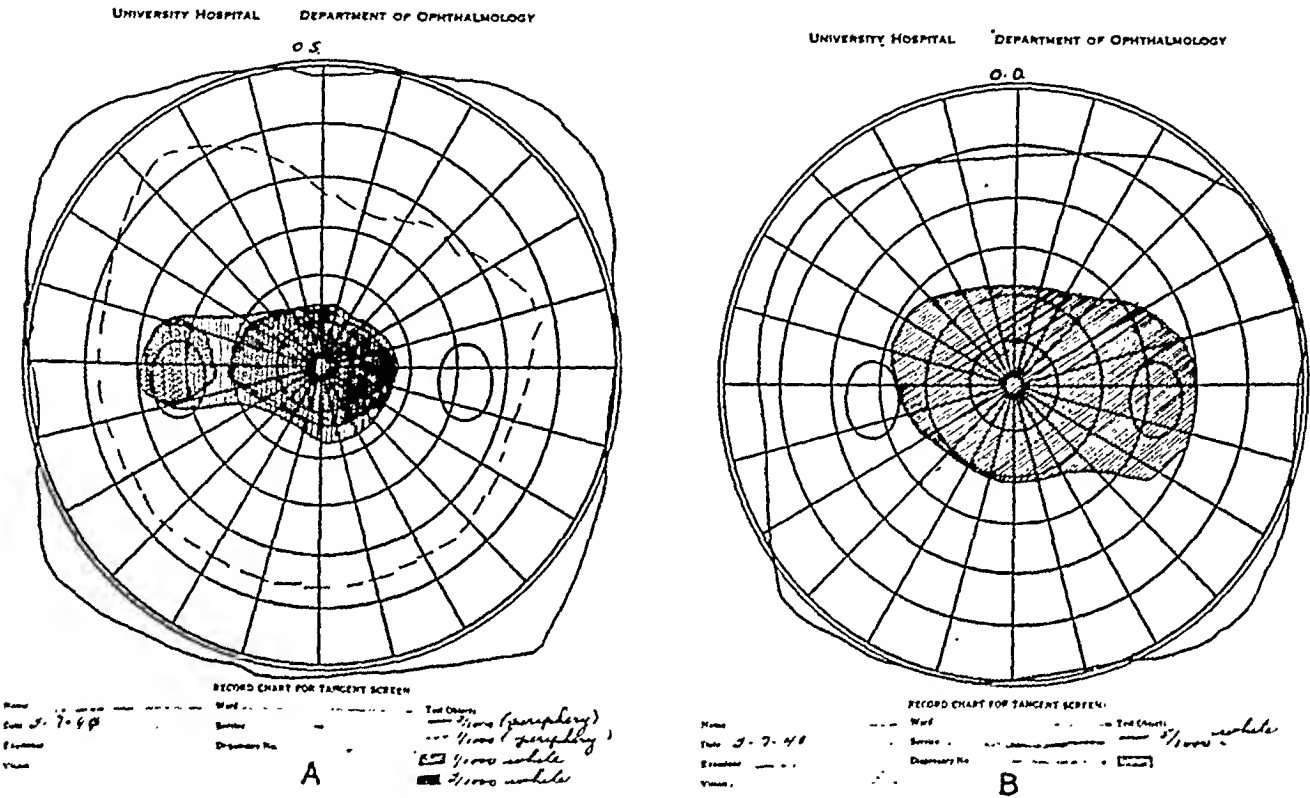


FIG. 13, A and B. Case II. There is a cecocentral scotoma in the left eye (A), and bilateral central scotoma (B).

urinary stream. He was referred to the eye service as a possible multiple sclerosis.

Comment. In this patient the cisterna chiasmatis is encroached upon above the chiasm and the superior portion of the cisterna interpeduncularis is also distorted (Fig. 12). Lillie's cases usually had compensatory subarachnoid channels in the frontal and occipital poles and the pathways around the islands of Reil were enlarged. It does not seem likely that the slight asymmetry of ventricles and cortical markings noted in this patient are related to the chiasmal lesion. Worthy of further note is the observation that the optic nerves were bound down by adhesions in close

rest. A few months later dimness returned in the left eye and soon after in the right eye. Three months before admission he noticed increased prominence of his right eye.

Physical examination revealed widening of the right palpebral fissure with exophthalmos on the right and bilateral loss of vision. Visual acuity in the right eye was 1/60 and in the left eye 6/60. The right disk was pale with a blurred margin. The optic cup was filled with connective tissue, and several perivascular sheaths were present. The left disk was similar but less marked. There were bilateral central scotomata and also a cecocentral one on the left, but the peripheral fields were only slightly contracted (Fig. 13, A and B).

Laboratory studies and roentgenograms of skull, orbits, and sinuses were negative.

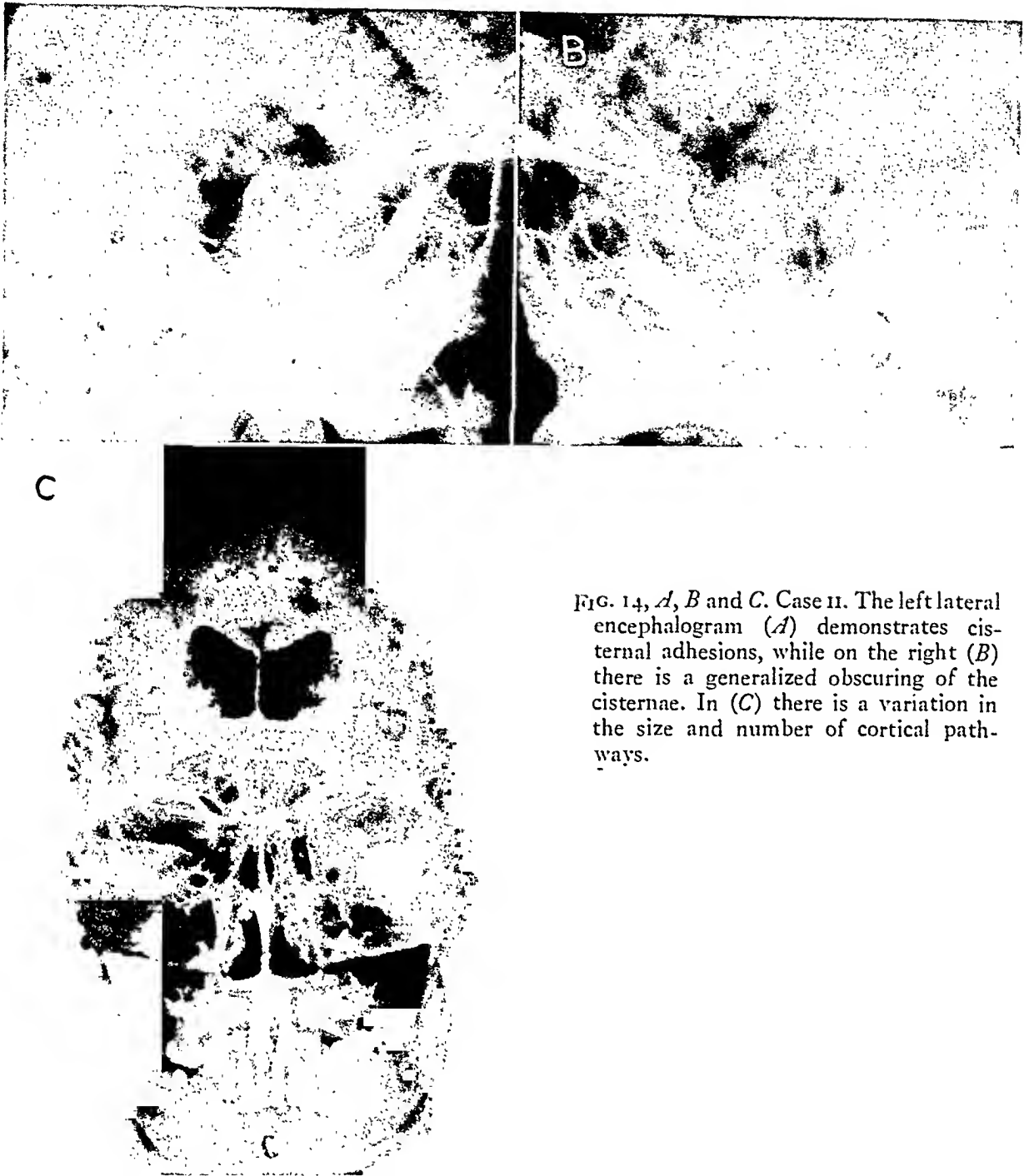


FIG. 14, *A*, *B* and *C*. Case II. The left lateral encephalogram (*A*) demonstrates cisternal adhesions, while on the right (*B*) there is a generalized obscuring of the cisternae. In (*C*) there is a variation in the size and number of cortical pathways.

An air encephalogram revealed the ventricular system to be slightly enlarged. The cortical pathways in the frontal and parietal regions were increased in prominence, and in the region of the vertex there was an absence of pathways which was believed due to incomplete drainage or arachnoiditis. The shadows of the cisternal chiasmatis and interpeduncularis were definitely abnormal (Fig. 14, *A* and *B*)

A right transfrontal craniotomy was performed on March 11, 1940, revealing the optic nerves enmeshed in unusually thick and tough

adhesions which could not be separated by dissection, but had to be cut with scissors. The optic nerves were thin, yellowish, and somewhat atrophic. The sella was entirely normal. The pituitary gland was not enlarged, and an excellent view of the pituitary stalk was obtained. Except for the presence of the marked adhesions, this region was entirely negative. Removal of the roof of the right orbit revealed no intraorbital tumor.

Re-examination January 15, 1941, revealed the patient's vision to be about the same with-

out improvement or sight loss. His visual acuity was 1/70 in the right eye and 20/70 in the left eye uncorrected.

Comment. Occasionally the roentgenologist may note that one side of the cisterna appears more extensively involved. In the

noting whether or not it has been removed from the spinal subarachnoid spaces and basal cisternae.

CASE III. This thirty-six year old white male was first seen in the eye clinic on June 13, 1944, complaining of visual loss for three months.

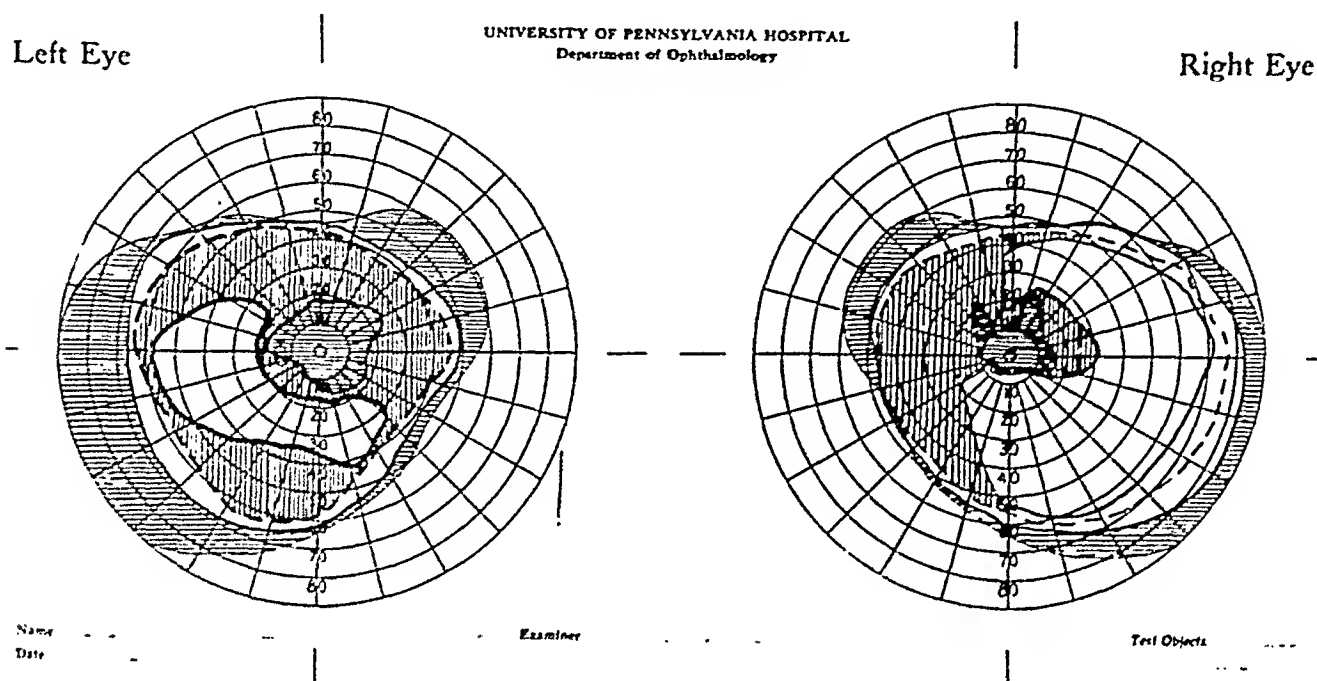


FIG. 15. Case III. This shows bilateral central scotomata.

above case the cisternae chiasmatis and interpeduncularis appear to be obscured more on the left, but clinically there was less involvement on this side. The difference may be explained by a pathological difference in the lesion on the two sides. On the left side numerous band-like structures can be seen crossing the cisternae, some of which may represent adhesions, the appearance is similar to that illustrated in Figure 1B. On the right there is a more uniform obscuring of the cisternae which may be due to a diffuse thickening of the arachnoid with or without cystic changes. The cisterna pontis is also obscured (Fig 14, A and B).

These changes were at first not observed by a junior member of the staff, further illustrating the necessity of suspecting the syndrome in patients with signs of optic nerve involvement. The roentgenologist should also make certain there has been adequate drainage of the spinal fluid by

Visual acuity at that time was 6/15 O. D. and 1/150 O. S., with correction. The left optic nerve was atrophic and the right blurred and very slightly elevated. Visual fields showed large central scotomata in the left and a very small one in the right which were not localized (Fig. 15).

He was admitted to the eye ward on June 28, 1944, because his visual loss was progressive. At this time his vision was 6/60 O. D. and 3/180 O. S. There was increased edema of the right nerve head, overfilling of the veins, and small hemorrhages near the disk, as well as atrophy of the left optic nerve (Foster Kennedy syndrome). Visual fields now, in addition to the central scotomata, showed a superior quadrantsopia which was incongruous. Except for a partial anosmia, physical examination was negative.

Roentgenographic studies revealed a suspicious tooth in the left maxillary region. Negative studies included a nose and throat consultation, chest, skull, and sinus roentgenograms, blood count, urine, serology, routine agglutinations, and spinal fluid. A pneumo-encephalogram

revealed lack of filling of the chiasmal subarachnoid cistern. The clinical diagnosis was a lesion in the left optic tract just behind the chiasm.

On September 26, 1944, he complained of continued loss of vision. His visual acuity was 3/120 O. D. and 1/120 O. S. The left optic nerve was still pale and the right one continued to show choking. There was pallor of the temporal portion of the right nerve head. Visual fields showed the large central scotomata with a binasal color cut.

A craniotomy on October 4, 1944, revealed both optic nerves were very definitely bound down to the sella by solid adhesions of grayish, thickened arachnoid. The adhesions were carefully cleaned away and a small fragment was taken for study.

Eight days, postoperative, his ocular status was believed to be worse. How much of this was functional and due to operative edema remained to be seen. Three weeks postoperative there was slight but definite improvement.

Comment. In this case the air shadow normally seen above the optic chiasm is obscured. Here also, as in the second case, the adhesions themselves can be seen as faint linear strands extending across the cisternae interpeduncularis and chiasmatis, obscuring the cisternae and the structures within them (Fig. 16).

CASE IV. This was the third admission, De-

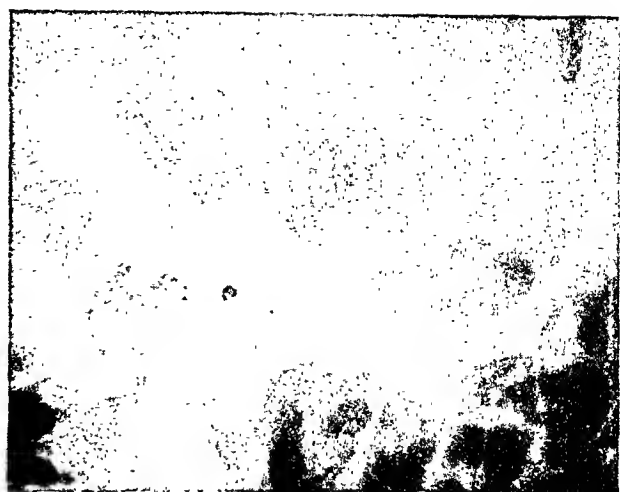


FIG. 16. Case III. Arachnoiditis obscuring the cisternae chiasmatis and interpeduncularis.

cember 3, 1941, of a forty-seven year old white mill-hand, complaining of "crossed eyes" and poor vision for three years. His past history revealed a head injury involving transitory loss of consciousness at the age of ten. Four years before this admission (1937), he began to notice a progressive diminution in his sense of smell and shooting pains appeared in various parts of his body. The following year his eyes began to cross and his vision became blurred. His doctor also told him he had a right facial paralysis. Two years ago a doctor took roentgenograms and told him he had a "tumor pressing the optic nerves." Soon after, he entered this hospital (March 28, 1940) where loss of olfactory sense,

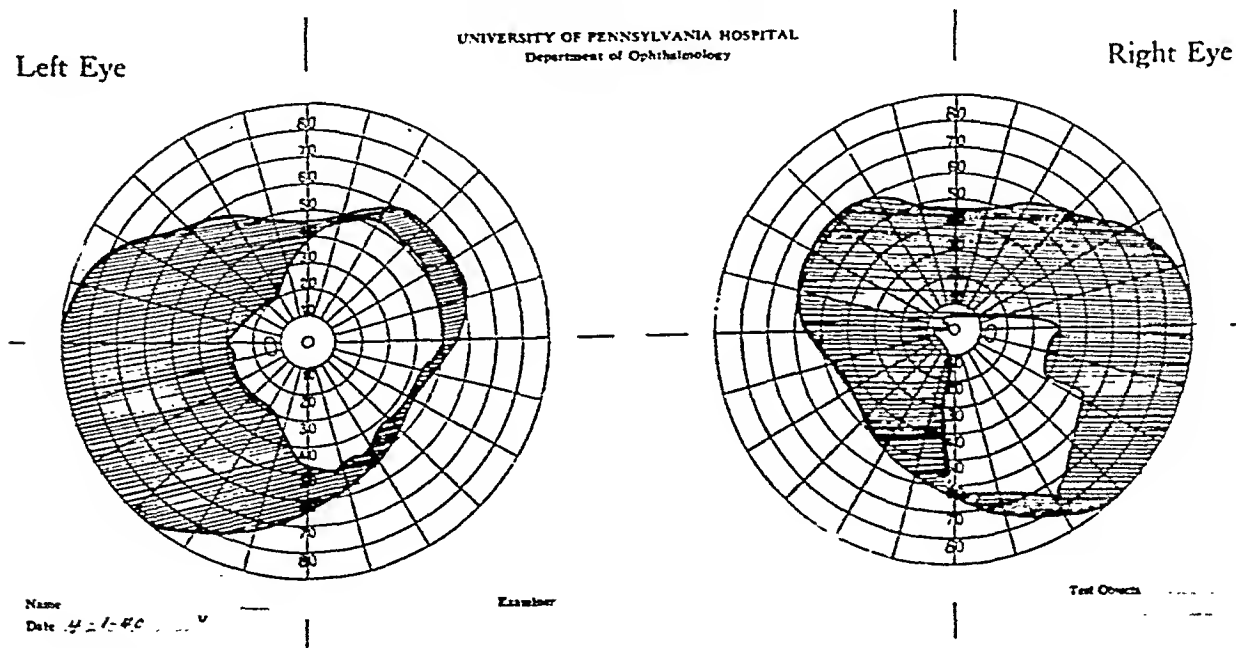


FIG. 17. Case IV. This shows a bilateral hemianopsia with contraction of the right nasal field.

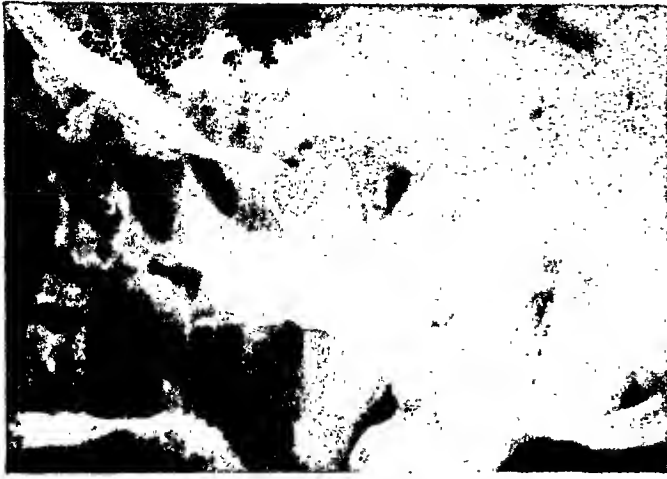


FIG. 18. Case IV. Poor visualization of the cisternae chiasmatis and interpeduncularis due to basal arachnoiditis.

abducens nerve paralysis, dilated fixed pupils, and bilateral primary optic atrophy, worse on the right, were noted. His vision was 6/60 O. S. but he was able only to count fingers at 1 foot with the right (Fig. 17). Subsequent significant studies: blood Wassermann weakly positive and negative, cerebrospinal fluid Wassermann medium positive on two occasions. Head roentgenograms revealed a nasopharyngeal tumor which on biopsy was lymphoid hyperplasia. Luetic therapy was begun on April 5, 1940, and he was discharged temporarily.

On February 11, 1941, he was readmitted. Although he had improved generally under luetic therapy, he had developed a slight stagger when walking and his vision had become progressively worse. At this time he had light perception only in the right eye and a left temporal hemianopsia. His spinal fluid Wassermann was more positive and the gold curve 4444444410. An encephalogram revealed bilateral cortical atrophy and poor visualization of the cisternae interpeduncularis and chiasmatis, possibly due to basal arachnoiditis (Fig. 18).

He was last admitted December 3, 1941, with a diagnosis of chiasmal arachnoiditis. A craniotomy was performed on December 5, 1941. A bluish mass (large vein) was first noted near the lateral side of the right optic nerve which on needling contained only blood. The chiasm was then exposed and many fine adhesions between the optic nerves and dura were cut so that the chiasm was freed.

Re-examination on April 14, 1942, revealed he could see hand movements only in the right eye with correction, and in the left eye visual acuity was 6/60. His pupils and fundi were un-

changed. On November 22, 1943, he was again seen and his visual acuity, fundi, and fields were unchanged.

Comment. We have included this case as an illustration of a chiasmal arachnoiditis with specific etiology, namely syphilis. Ten per cent of Bollack's cases had positive blood and/or spinal fluid Wassermann reactions.² The clinician and roentgenologist must be cognizant of this possibility when examining syphilitics with eye symptoms. Hausman⁸ has emphasized that visual field defects and optic atrophy in syphilitic patients do not, in the absence of other neurologic signs, necessarily denote tabes. In his opinion, syphilitic basilar meningitis is much more frequent than generally supposed. The roentgenologist may in the future contribute much to the proof or disproof of this belief (Fig. 18).

CASE V. This was a forty-one year old woman complaining of failing vision for four years. Her past history revealed pneumonia in childhood, rheumatic fever at seventeen, an appendectomy four years before, and radium implantation for uterine fibroids four months before.

Four years before admission on November 5, 1941, the vision in her left eye began to fail and progressed to light perception only. The vision in the right eye began to fail four months prior to admission. Significant physical findings were limited to the eyes. There was light perception only in the left eye and 6/30 vision in the right eye with only slight contraction of the field. The light reflex on the right was absent but the consensual reflex was present. The left optic disk was atrophic, and the temporal half of the right disk slightly pale.

An encephalogram was interpreted arachnoiditis, cortical atrophy, and a possible mass lesion in the chiasmal region (Fig. 19, A and B).

On the third day of admission a small suprasellar meningioma involving the sella turcica and springing from the left olfactory groove was incompletely removed because of its proximity to the carotid arteries. The right optic nerve was freed from its involvement by the tumor.

She was re-examined March 18, 1942, as an out-patient. There was little vision in the left eye, the vision in her right was improved to 6/9 and the visual field was full.

Comment. This patient is a good example of the occasional tumor case in which it is not only difficult to differentiate between tumor and arachnoiditis before but also after encephalography. If the sella turcica is enlarged or eroded, one should immediately suspect a tumor. In this instance a rather large shadow in the region of the

arachnoiditis with poor visualization of the basal cisternae and subarachnoid pathways over one or both hemispheres. Usually there is also some degree of hydrocephalus.

CASE VI. The patient was a twenty-two year old girl whose only symptom was attacks of jacksonian convulsions involving the right side of the body for one year. Physical examination

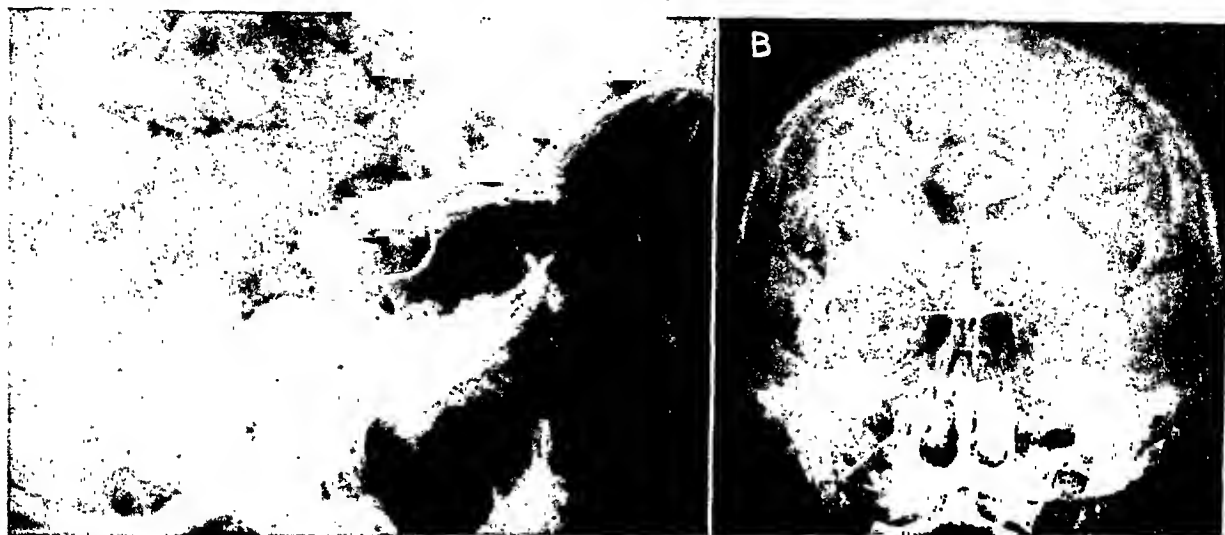


FIG. 19, *A* and *B*. Case v. Distortion of the cisterna chiasmatis by a suprasellar meningioma (*A*), with concomitant arachnoiditis and cortical atrophy (*B*).

optic chiasm was noted and the correct diagnosis was made (Fig. 19*A*).

This case, as well as the second, illustrates the necessity of evaluating carefully the structures in the region of the cisterna chiasmatis. Another interesting feature is that the tumor was small enough not to block the midline and lateral subarachnoid pathways.

We do not wish to convey the impression that every distortion of the encephalographic appearance of the cisternae in the region of the optic chiasm is necessarily pathognomonic of a disease or tumor involving the optic nerves or tracts or the adjacent structures. We do wish to emphasize the importance of recognizing the normal pattern and its normal variants.

There is another group of patients usually referred to the roentgenologist for encephalography because of jacksonian epilepsy. These patients have no eye signs or symptoms but the appearance of the air study is suggestive of generalized or basal

revealed infected tonsils, slight deviation of the tongue to the right upon protrusion, slight ptosis of the right eyelid, and greater activity of the tendon reflexes on the right side. There were no eye signs or symptoms. An encephalogram was done revealing moderate dilatation of the ventricular system and almost complete lack of filling of the subarachnoid pathways. The cisterna chiasmatis is apparently obliterated and the cisterna interpeduncularis is encroached upon (Fig. 20*A*). A craniotomy was performed and a blood clot, microscopically fresh in appearance, was removed. An encephalogram performed nine months later showed better, but irregular, filling of the cisternae chiasmatis and interpeduncularis (Fig. 20*C*).

CASE VII. The patient was a boy, aged sixteen, with convulsions involving the left side of the body and mental retardation for thirteen years. He had a severe attack of "brain fever" in infancy. Complete examination revealed only mental retardation. The encephalogram (Fig. 21) shows slight dilatation and asymmetry of the lateral ventricles and absence of air in the subarachnoid pathways over the cortex.

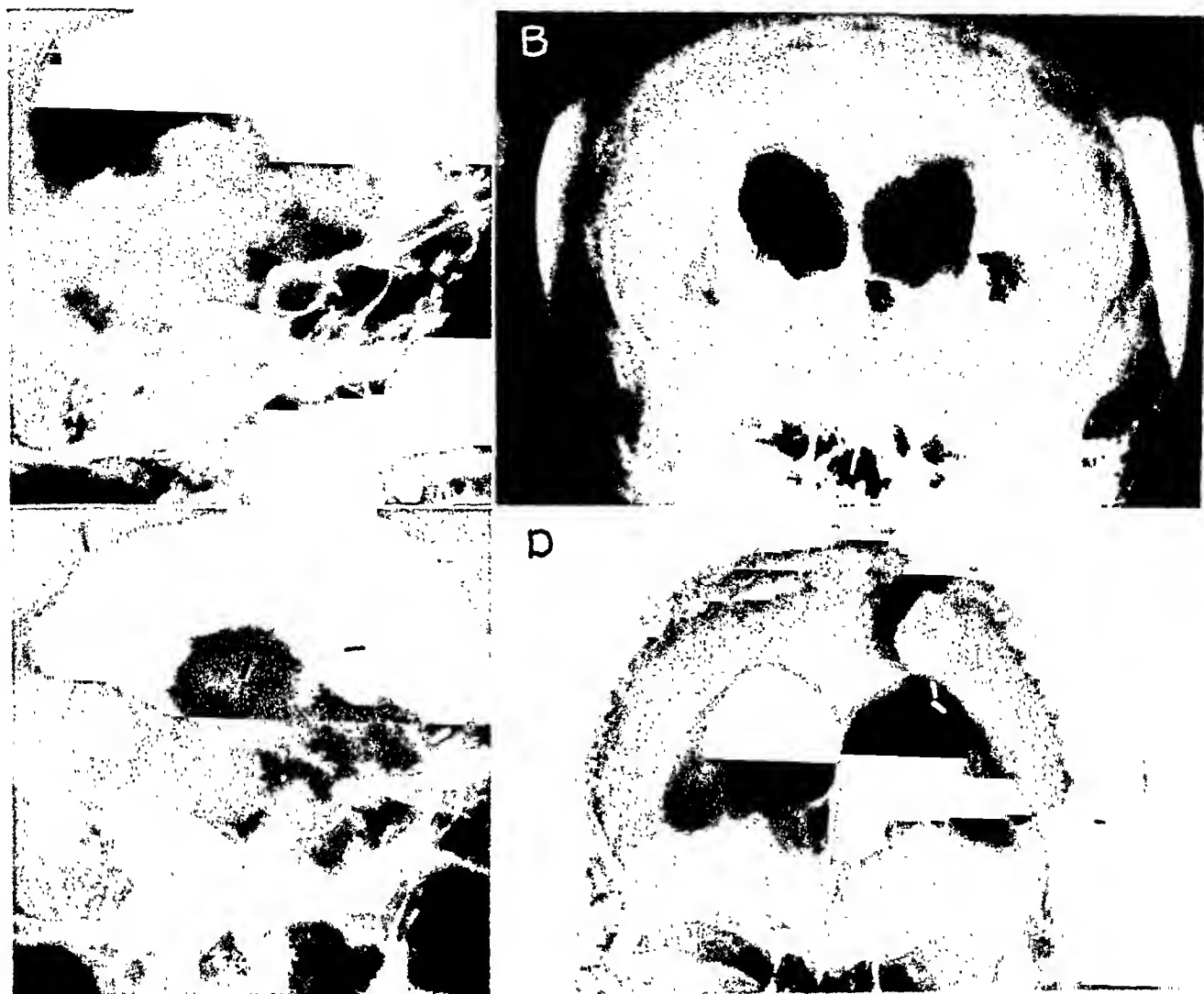


FIG. 20, *A*, *B*, *C* and *D*. Case vi. The cisternae chiasmatis and interpeduncularis are almost completely obliterated (*A*), and there is little filling of the subarachnoid pathways (*B*). There is better filling after operation (*C*) and (*D*).



The cisternae chiasmatis and interpeduncularis are encroached upon by a homogeneous shadow appearing continuous with the surrounding structures.

CASE VIII. The patient was a male, aged fifty, who had been exhibiting personality changes for twenty-five years and jacksonian convulsions for fifteen years. He had been kicked in the head by a horse and severely injured at ten years of age. Complete examination revealed only infected tonsils and teeth. The encephalogram (Fig. 22) revealed few subarachnoid pathways and the cisternae chiasmatis and interpeduncularis were blurred and distorted. A

FIG. 21. Case vii. There is uniform encroachment upon the cisternae chiasmatis and interpeduncularis with absence of subarachnoid pathways.

small amount of air was trapped in the posterior horn of the lateral ventricle simulating somewhat the appearance of a cyst communicating with the ventricle.

Comment. The roentgenographic appearance described in Cases VI, VII, and VIII is typical of either generalized arachnoiditis or basal arachnoiditis causing obstruction of the flow of cerebrospinal fluid from the basal cisternae and the foramina of Magendie and Luschka of the fourth ventricle which in turn results in dilatation of the ventricles and prevents filling of the subarachnoid pathways. When the roentgenologist is confronted with cases such as these without eye symptoms, he should recommend ophthalmoscopic and visual field studies if they have not already been done.

CASE IX. The patient was a male, aged fifty-eight, who had received severe head trauma one year before admission. Six weeks after the accident he began to have headaches in the region of the left temple and noticed numbness and weakness in the right hand and foot which progressed to his shoulder and hip. Examination revealed impaired intellect, right hemiparesis, mild arteriosclerosis, and pulmonary emphysema. The encephalogram (Fig. 23) shows slight en-



FIG. 22. Case VIII. There is blurring and distortion of the cisternae with few subarachnoid pathways.



FIG. 23. Case IX. The cisternae are poorly visualized but there is inadequate drainage of cerebrospinal fluid.

largement of the lateral ventricles, greater on the left. There are fewer subarachnoid pathways over the left frontoparietal region and the cisternae chiasmatis and interpeduncularis are poorly visualized.

Comment. This patient could have a localized arachnoiditis or a basal arachnoiditis which has interfered with drainage of the spinal fluid from the subarachnoid pathways. However, the interpretation of the appearance of the cisternae must be qualified for *it is most important to note there is poor visualization of the fourth ventricle and no air in the spinal subarachnoid spaces, indicating inadequate drainage of the spinal fluid previous to air injection.*

CASE X. This patient was a six year old boy who had had two jacksonian convulsions during the preceding four months. Neurological examination was negative and as in Cases VI, VII, VIII, and IX, there were no eye signs or symptoms. An electro-encephalogram was indicative of a focal lesion in the left temporal region. There is a reduction in the number of subarachnoid pathways in the encephalogram (Fig. 24) and the cisterna chiasmatis is not seen.

Comment. It is obvious that the spinal fluid drainage has been incomplete for the

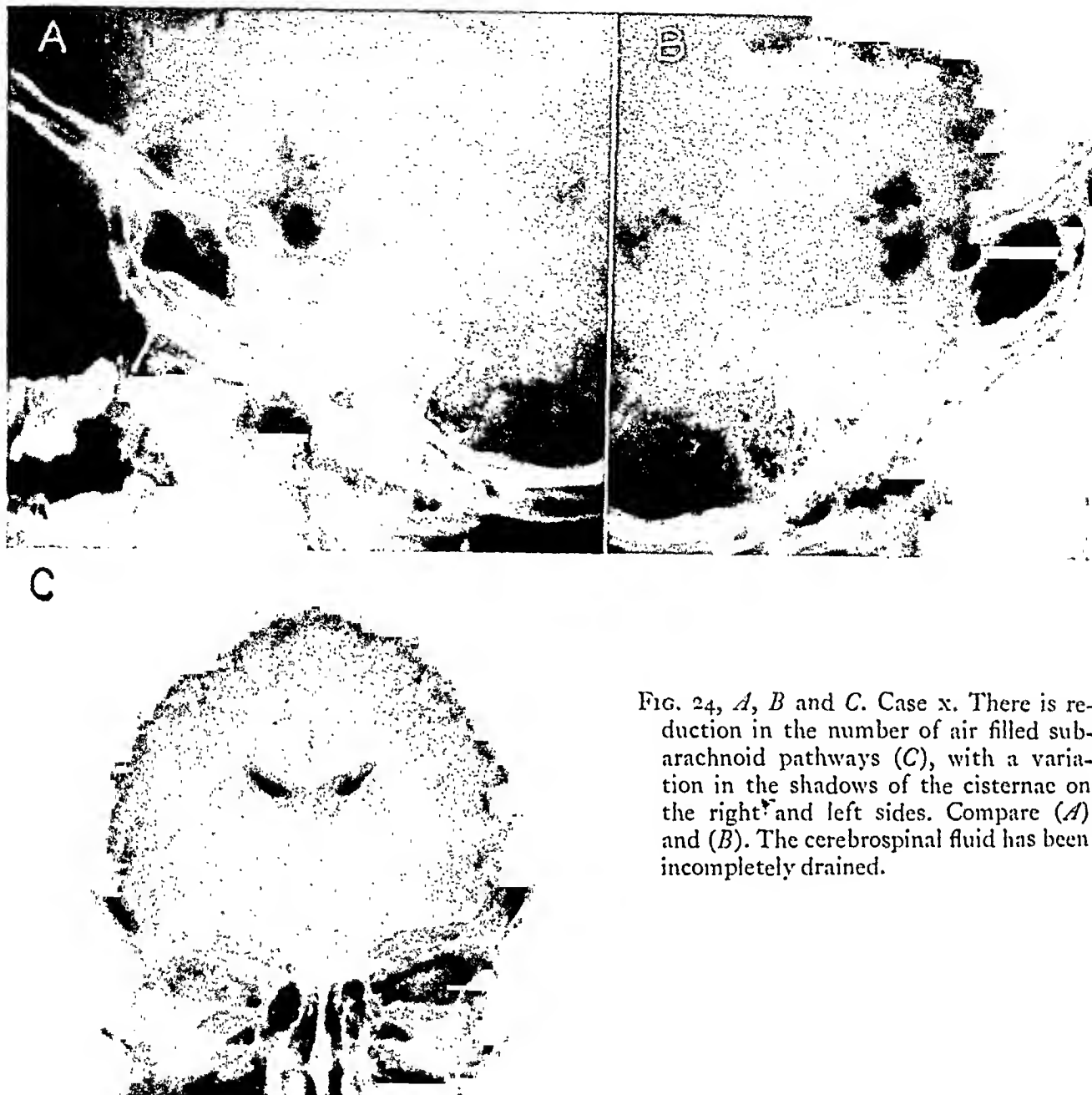


FIG. 24, *A*, *B* and *C*. Case x. There is reduction in the number of air filled subarachnoid pathways (*C*), with a variation in the shadows of the cisternae on the right and left sides. Compare (*A*) and (*B*). The cerebrospinal fluid has been incompletely drained.

lateral ventricles are only partially drained. Note the difference in the appearance of the cisterna interpeduncularis in the right and left sagittal views. A diagnosis of arachnoiditis would not be justified without a more satisfactory study following complete drainage of the spinal fluid. This case and Case ix illustrate the necessity for adequate drainage of spinal fluid during the procedure of encephalography in patients suspected of arachnoiditis.

SUMMARY

Optochiasmatic arachnoiditis is an in-

flammatory process which produces a syndrome that is similar to that produced by a tumor in the region of the optic chiasm.

Four cases of chiasmatic arachnoiditis, one of luetic origin, are presented. The condition cannot be diagnosed by conventional roentgenograms, but can be by employing pneumo-encephalography.

The normal cisternae in the region of the optic chiasm and some of the structures within and adjacent to them are described.

The encephalographic findings in optochiasmatic arachnoiditis are rather typical in some instances, in others suggestive.

These include shadow patterns of adhesions, cysts or complete obliteration of the air shadows of the basal cisternae in the region of the optic chiasm.

Pitfalls in diagnosis are discussed and illustrated. These include errors in technique such as incomplete drainage and examinations in the horizontal posture employing a vertical beam.

Lesions such as a tumor in the region of the optic chiasm are shown to illustrate the difficulty of differential diagnosis in some instances.

This condition can be diagnosed in most instances by the roentgenologist with the aid of pneumo-encephalograms if optochiasmatic arachnoiditis is suspected.

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REFERENCES

1. BALADO, M., and SATANOWSKY, P. Tratamiento quirúrgico de la atrofia de la papila. *Arch. argent. de neurol.*, 1929, 4, 71-75.
2. BOLLACK, J., DAVID, M., and PUECH, P. Les arachnoïdites opto-chiasmatiques: Etude ophthalmologique et neuro-chirurgicale. Masson et Cie, Paris, 1937.
3. BOURGEOIS, H., BOURGEOIS, R., LAPONGE, A. M. J., ROGER, H., COSSA, P., CARLOTTI, P., VINCENT, CL., PUECH, and BERDET. Les arachnoïdites de la base du cerveau. *Rev. d'oto-neuro-opht.*, 1936, 14, 321; 385.
4. CRAIG, W. M., and LILLIE, W. I. Chiasmal syndrome produced by chronic local arachnoiditis; report of 8 cases. *Arch. Ophth.*, 1931, 5, 558-574.
5. DESVIGNES, P. Le syndrome de compression directe du nerf optique intracrânien. *Ann. d'ocul.*, 1937, 174, 289-308.
6. DAVIDOFF, L. M., and DYKE, C. G. The Normal Encephalogram. Lea & Febiger, Philadelphia, 1937.
7. GOLDSMITH, A. J. B. Chiasmal arachnoiditis. *Proc. Roy. Soc. Med.*, 1943, 36, 163-168.
8. HAUSMAN, L. Syphilitic arachnoiditis of optic chiasm. *Arch. Neurol. & Psychiat.*, 1937, 37, 929-958.
9. HAUSMAN, L. Syphilitic papilledema without increase in intracranial pressure; its relation to lesions at chiasm. *J. Mt. Sinai Hosp.*, 1942, 9, 544-556.
10. HERMANN, P. Maladie de Leber (arbre généalogique avec 7 cas, une observation avec arachnoïdite opto-chiasmatique). *Arch. d'opht.*, 1940, 3, 784-790.
11. HEUER, G. J., and VAIL, D. T., JR. Chronic cisternal arachnoiditis producing symptoms of involvement of optic nerves and chiasm; pathology and results of operative treatment in 4 cases. *Arch. Ophth.*, 1931, 5, 334-349.
12. HOLMES, GORDON. Suprasellar tumors. *Congrès périodique internat. d'opht.*, 1929, 3, 65-79.
13. KALT, M., PUECH, P., and KREBS, E. Sur un cas d'arachnoïdite opto-chiasmatique consécutive à une contusion sans plaie de la région palpébrale droite. *Bull. Soc. d'opht. de Paris*, 1937, 49, 291-297.
14. KENEL, C. Cinq cas d'arachnoïdite optico-chiasmatique d'origine traumatique, dont quatre confirmés opératoirement. *Ophthalmologica*, 1939, 96, 336-345.
15. KENNEDY, F. S., and FISHER, J. H. Syphilis of pituitary body; case report with review of literature. *Am. J. Syph. & Neurol.*, 1934, 18, 12-23.
16. LILLIE, W. I. Prechiasmal syndrome produced by chronic local arachnoiditis; report of 3 cases. *Tr. Sect. Ophth., A. M. A.*, 1940, 260-268; also, *Arch. Ophth.*, 1940, 24, 940-947.
17. LILLIE, W. I. Personal communication.
18. QUINCKE, H. I. Ueber meningitis serosa. *Samml. klin. Vortr.*, n. F., Leipzig, 1893, No. 67 (Innere Med., No. 23, 655-694).
19. RUBINO, A. Cisti idatidea del IV ventricolo con leptomeningite otto-chiasmatica; studio anatomico-clinico. *Riv. di pat. nerv.*, 1939, 53, 249-288.
20. RYAN, E. R. Optochiasmatic arachnoiditis; report of 3 cases. *Arch. Ophth.*, 1943, 29, 818-825.
21. SCHAEFFER, J. P. Some points in the regional anatomy of the optic pathway, with especial reference to tumors of the hypophysis cerebri and resulting ocular changes. *Anat. Rec.*, 1924, 28, 243-279.
22. SCHLESINGER, HERMANN. Beiträge zur Klinik der Rückenmarks und Wirbel-tumoren. Gustav Fischer, Jena, 1898.
23. SPILLER, W. G., MUSSER, J. H., and MARTIN, EDWARD. A case of intradural spinal cyst with operation and recovery. *Univ. of Pennsylvania M. Bull.*, 1903, pp. 25-31.

24. VAIL, D. Optochiasmic arachnoiditis; importance of mixed type of atrophy of optic nerve as diagnostic sign. *Arch. Ophth.*, 1938, 20, 384-394.
25. VAIL, D. Syphilitic opticochiasmatic arachnoiditis. *Am. J. Ophth.*, 1939, 22, 505-517.
26. WAGENER, H. P., and CUSICK, P. L. Chiasmal syndromes produced by lesions in posterior fossa. *Arch. Ophth.*, 1937, 18, 887-891.
37. WORMS, G. Syndrome oculo-hypophysaire consécutif à une sinusite sphénoïdale suppurée; examen anatomo-pathologique. *Arch. d'ophth.*, 1936, 53, 207-217.



SOME OBSERVATIONS CONCERNING THE HYPOPHYSIAL FOSSA*

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INTRODUCTION

IN 1886 Pierre Marie described a syndrome which he called acromegaly. A year later Minkowski suggested that this syndrome might be caused by a lesion of the pituitary body. In 1898 Oppenheim recognized that intracranial disease might be reflected in roentgenograms of the skull. He was the first to diagnose a pituitary adenoma by roentgen study. In 1902 Fuchs and Holtzknecht, without prior knowledge of Oppenheim's study, reported a similar case in which there was widening and deepening of the pituitary fossa due to tumor. In 1909 Gramegna treated the first case of pituitary tumor with temporary improvement of the patient's symptoms (acromegaly). Between 1909 and 1914 Bécclère reported several cases of this disease which were improved by roentgen therapy. He states that anterior lobe tumors of the hypophysis were the only intracranial neoformations which one could say with certainty would be improved by roentgen therapy.²⁹ In 1922 Schüller gave credit to Erdheim for teaching the differentiation between sellar changes resulting from adenoma and those due to extrasellar tumors. In 1915 Kupferle and von Szily described the advantages of postoperative roentgen therapy. The date of the first surgical exploration was February, 1902.⁸ The above historical facts have been obtained from the relatively recent writings of Pancoast,²⁵ Pohle²⁹ Dyke and Davidoff,¹¹ and others.

It should be recalled that prior to 1926 surgical access to the gland was by the trans-sphenoidal route. Following 1926, however, the approach of choice has been right frontal craniotomy (transfrontal route). At the present time there are two schools of thought regarding therapy: (1)

those who favor postoperative irradiation, and (2) those who feel that post-irradiation surgery is often the most acceptable procedure.

Mayfield²¹ believes that surgery is often facilitated by prior deep therapy, the tumors thus being more sharply demarcated and, therefore, more readily enucleable. In favor of surgery is the rapid decompression of the brain, the relief of tension on the optic chiasm, and the advantages of surgical biopsy. Against immediate operation is a relatively high mortality rate ranging between 10 and 20 per cent in some clinics.¹⁶ In this connection it is interesting to speculate upon the decongestive effect which roentgen therapy must have on highly vascular adenomas such as one recently encountered in this hospital. Attention is also directed to the value of irradiation in cases where very little optic reserve remains; in other words, in those patients whose visual fields show evidence of extensive damage with only small residual seeing areas present. Operation in such instances, due to edema and other factors not clearly understood, may result in total loss of vision. Cautious roentgen therapy in such cases would appear to be the preferable method. Pfahler and Spackman²⁸ state that cystic changes occur in 20 per cent of adenomas while 80 per cent are solid. The latter are, in the broad sense, the only tumors which can be considered radiosensitive, although there is still appreciable individual variation. It is not within the scope of this paper to consider the therapy of pituitary tumors in detail, however. The above facts will serve to indicate that each case must be individualized and an impartial course followed. Marked preference for either irradiation or surgery alone is unlikely to result in optimum benefit to the patient.

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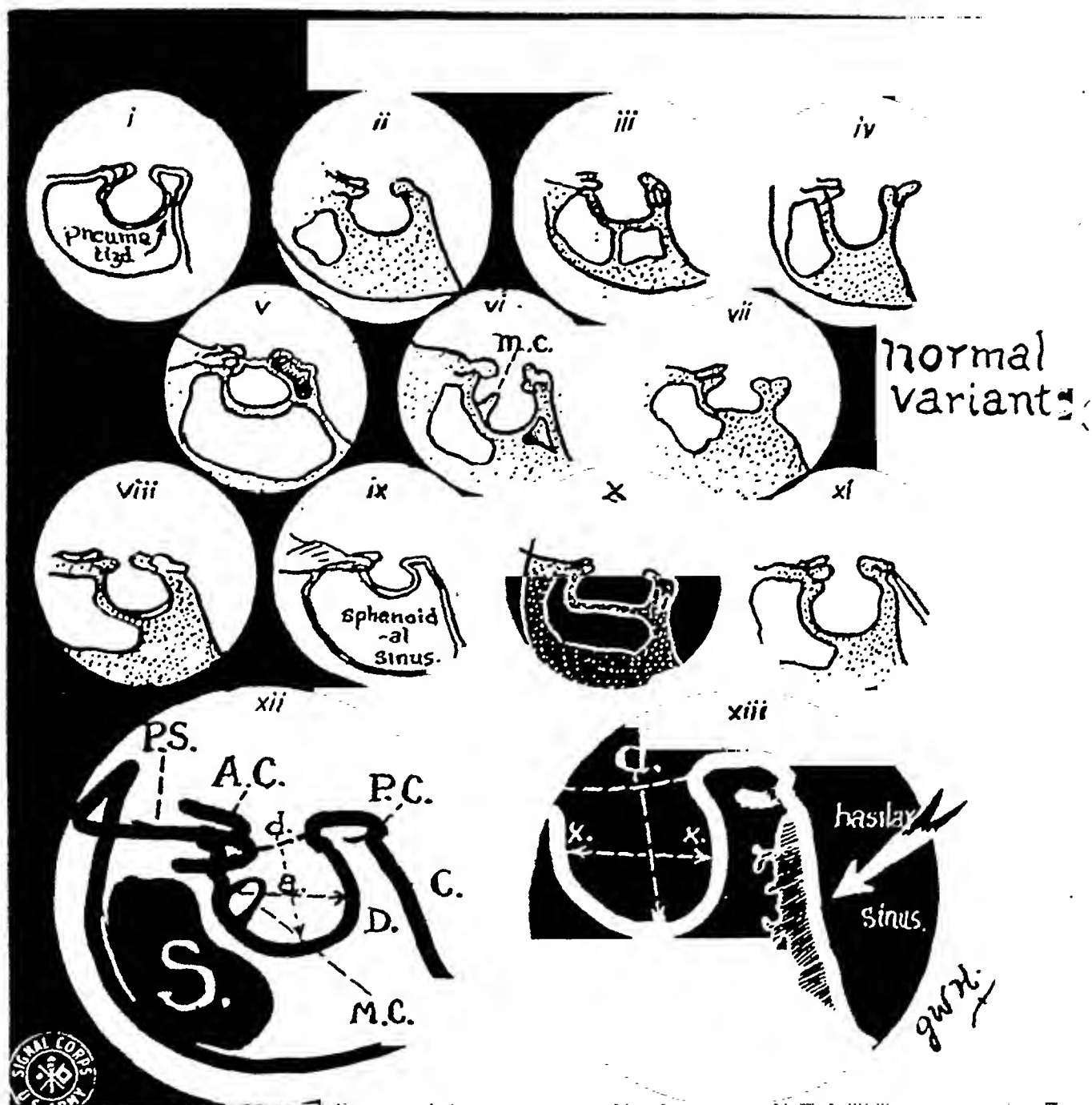


FIG. 1. *i*, extensive pneumatization of the dorsum. *ii*, hook-bill type of dorsum with oval contour. *iii*, partial pneumatization of the dorsum sellae. *iv*, marked prominence of the posterior clinoid processes. *v*, partial pneumatization of the dorsum with bridging between the anterior and posterior clinoids. *vi*, middle clinoid is well developed at *m.c.* *vii*, oblong type of sella turcica with bulbous dorsum and pointed anterior clinoids directed superiorly. *viii*, hooked or beaked type of sella turcica. *ix*, extensive pneumatization of the dorsum sellae with small hypophysial fossa. *x*, flat type of pituitary fossa. *xi*, circular type of pituitary fossa with evidence of physiological calcification in the petroclinoid ligaments. *xii*, *P.S.* is the planum sphenoidale. Anterior clinoids at *A.C.* Posterior clinoids at *P.C.* Clivus at *C.* Dorsum at *D.* Middle clinoid at *M.C.* Position of diaphragma at *d.* Anteroposterior diameter at *a.* Sphenoidal sinus at *S.* *xiii*, normal basilar sinus modified from Kornblum. At *d* is shown the normal curvilinear concave sweep of the diaphragma sella from which the vertical dimension is measured. *x-x* equals the anteroposterior dimension used in measuring the pituitary fossa. Basilar sinus at arrow.

NORMAL MEASUREMENTS AND VARIANTS

In a recent clinical-roentgenological conference held in our hospital* considerable variance of opinion was expressed regarding the normal size of the pituitary fossa of young male adults. Doubt was expressed as to the validity of previously reported pituitary measurements. With this in mind, from a group of 614 skull examinations made during the year ending December 31, 1944, 100 apparently normal cases were selected for study. The pituitary fossas were measured according to the technique of Pendergrass²⁶ and Kornblum.¹⁹ Their method is graphically illustrated in Figure 1, *xii* and *xiii*. Guided by previous experience in measuring various dimensions of the infant skull¹⁴ calipers were used to determine, as accurately as possible, each diameter under consideration. The various types of sella turcica were also noted and classified. Our results are indicated in Table I.

TABLE I

Number of cases measured	100
Average anteroposterior diameter	10.66 mm.
Average depth	8.30 mm.
Range	Anteroposterior 13 X depth 9 mm.—Largest fossa
	Anteroposterior 8 X depth 5 mm.—Smallest fossa

These figures agree closely with those reported by Kornblum¹⁹ who found 10 X 8 mm. the normal average of 1,000 cases measured. His upper limits of normal, anteroposterior 12 X depth 10 mm., parallel our own, anteroposterior 13 X depth 9 mm. By comparison the average measurement of fossas of 6 patients with chromophobe adenomas encountered during the last year was anteroposterior 23 X depth 17 mm. In 1 case of malignant adenoma, however, which is reported in detail below, measurements were found to be somewhat less (anteroposterior 20 X depth 10 mm.)

Seven per cent of our cases showed bridging of the sella, comparing favorably

with Camp's figure of 5.5 per cent. Bridging is usually between the anterior and posterior clinoids, but in 1 of our cases (Fig. 2) it was between the middle and posterior clinoids. The usual contour was oval, 53 per cent; a round contour was present in 28 per cent while in 19 per cent the sella was either oblong or flat. The average measurements in children are

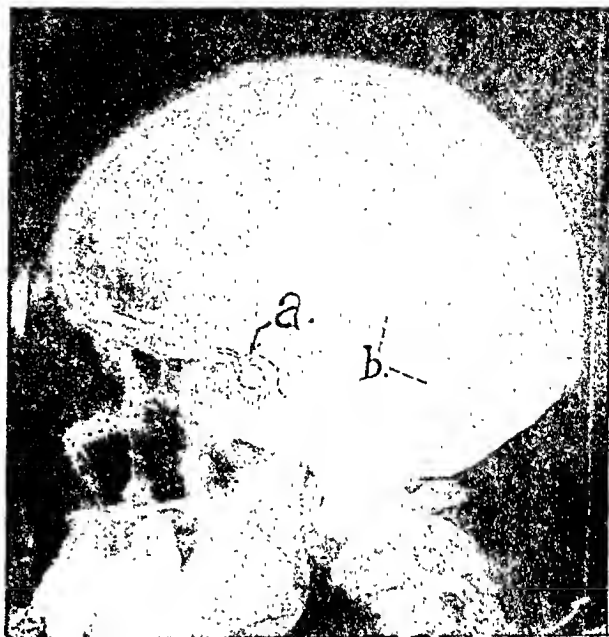


FIG. 2. Unusual bridging of the pituitary fossa, due to ossification between the middle and posterior clinoids on one side.

somewhat less than those above. Pendergrass²⁶ finds that between six to ten years of age the anteroposterior diameter is 7 to 8 mm. X depth 6 to 7 mm.

During our survey numerous interesting normal variants were encountered and are shown in Figure 1. In drawing *iv* is seen an unusual posterior clinoid. In *vi* is shown the appearance of the normal middle clinoid, which often acts as a flying buttress to form the entrance to the carotoclinoid canal. In from *i*-*xi* inclusive can be seen the various degrees of pneumatization which one may expect to find in a hundred skull studies. The dorsum sellae is often partially or wholly invaded by the sphenoidal sinus. In addition to the straight-backed sella and the bridged sella, men-

* Percy Jones General and Convalescent Hospital.

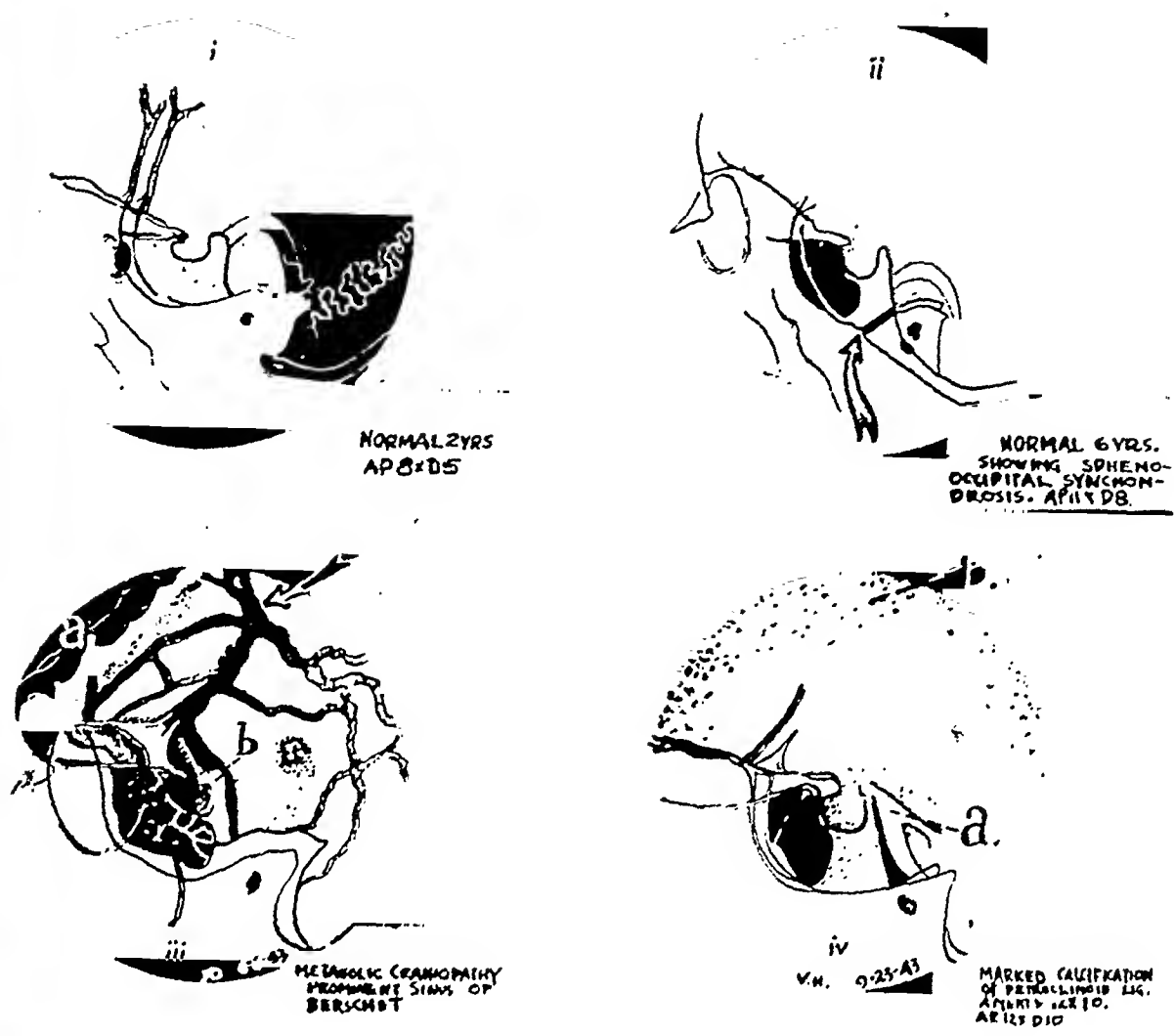


FIG. 3. *i*, normal appearance of sella turcica in child, aged two. Anteroposterior 8 and depth 5 mm. *ii*, normal appearance at six years. Note the normal sphenoccipital synchondrosis. On the roentgenogram this usually disappears between eight and twelve years of age. *iii*, appearance of sphenoparietal sinus of Berschet. Due to the prominence of the sphenoparietal sinus in this individual a diagnosis of meningioma was made elsewhere. The patient's headaches were apparently due to a metabolic craniopathy shown at *a*. The sinus of Berschet is shown at the arrow and continuing down behind the lesser wing of the sphenoid to enter the anterior portion of the cavernous sinus. The dorsum sellae is shown at *b* and appears considerably demineralized. *iv*, marked calcification of the petroclinoid ligaments in patient with von Recklinghausen's disease (parathyroid tumor). Marked porosity of the calvarium is shown at *b*. Calcification of the petroclinoid ligaments is at *a*.

tioned above, two main types of dorsum are encountered, the hooked type (*viii*) and the clubbed shaped type (*vii*) shown in the drawing. In Figure 1, *xiii*, attention is called to a little known sinusoidal system described by Kornblum. The drawing is slightly modified from Kornblum's original illustration. This is the basilar sinus which, according to Batson, lies between the dura and the clivus. It communicates with the cavernous and the inferior petrosal sinuses bilaterally. Pulsation of the brain is said to

be transmitted to the basilar sinus in such a manner that demineralization may result.¹⁹ This decalcification must be differentiated from the "senile atrophy" described by Schüller,³⁰ or the demineralization produced by minute basophilic adenomas. One might expect that a persistent rest of the notochord, the so-called ecchondrosis physalifera² would cause a similar appearance.

The roentgenologist must be conversant with numerous normal variants in the im-

mediate vicinity of the sella. Small vessels are not infrequently seen arising from the floor of the middle fossa. These course in an axial direction across the squamosal portion of the temporal bone. In the lateral roentgenogram of the skull these channels may appear superimposed on the hypophysial fossa (Fig. 4, *i*), thus simulating fracture lines. These vascular markings are not dissimilar in appearance to the grooves of the anterior meningeal arteries, the latter arising from the anterior ethmoidals in the frontal region. Only two fractures involving the sella have been encountered during the past year, one of which is illustrated in Figure 7, *i*. The elevation of the cortical bone forming the floor of the fossa, and the sharp demarcation of the fracture line hardly leave doubt as to the diagnosis. So far we have not found a complete fracture of the dorsum due to shearing forces exerted along the petroclinoid ligaments, such as has been described by Pancoast and his associates in their excellent text of neuro-roentgenology.²⁶

In our experience, the sinus of Berschet, first described in 1831³ has often been incorrectly considered to be the channel of the middle meningeal artery. This channel, also known as the sphenoparietal sinus, appears to arise from a venous lake near the sagittal suture. Its course, meandering at first, ultimately becomes straight, extending downward just dorsal to the lesser wing of the sphenoid to pierce the sphenoidal dura and enter the cavernous sinus anteriorly. A large sinus of Berschet, recently encountered here, was incorrectly diagnosed elsewhere as evidence of the presence of a meningioma. Time, however, has proved that the patient did not have an intracranial neoplasm. The symptoms were explained satisfactorily on the basis of a metabolic craniopathy (Fig. 3, *iii*).

Calcification of the petroclinoid ligaments is a well known entity. An unusually extensive ossification of these ligaments was recently observed in our department. This patient had a proved parathyroid tumor.⁴ It is not unlikely that in this particular in-

stance the hypercalcemia, which amounted to 17 mg. per 100 cc., accounted for the unusual density of these ligamentous structures; an accentuation, as it were, of a normal variant. Marked porosity of the calvarium was present, a kind of "salt and pepper" effect which would likely have led



FIG. 3*A*. Illustration showing a large sinus of Berschet in patient with metabolic craniopathy (Sherwood Moore). Hyperostosis frontalis interna is shown at *a*. The markedly demineralized sella is outlined at *b* and sinus of Berschet is indicated by arrows.

to the correct diagnosis even without the aid of long bone studies (Fig. 3, *iv*). A not infrequent normal variant, which may give rise to confusion, is the presence of a small hyperostosis projecting from the internal surface of the squamosal portion of the temporal bone (Fig. 5, *i*). Such a density may simulate a calcific deposit within the hypophysis itself, but its true nature is readily recognized when the roentgenograms are viewed stereoscopically. It should be recalled that calcium deposits may be found within the pituitary gland due to degenerative changes and are not necessarily of clinical importance.²⁷ Faint calcification above the level of the diaphragma, however, is of great importance and more than likely indicates the presence of a

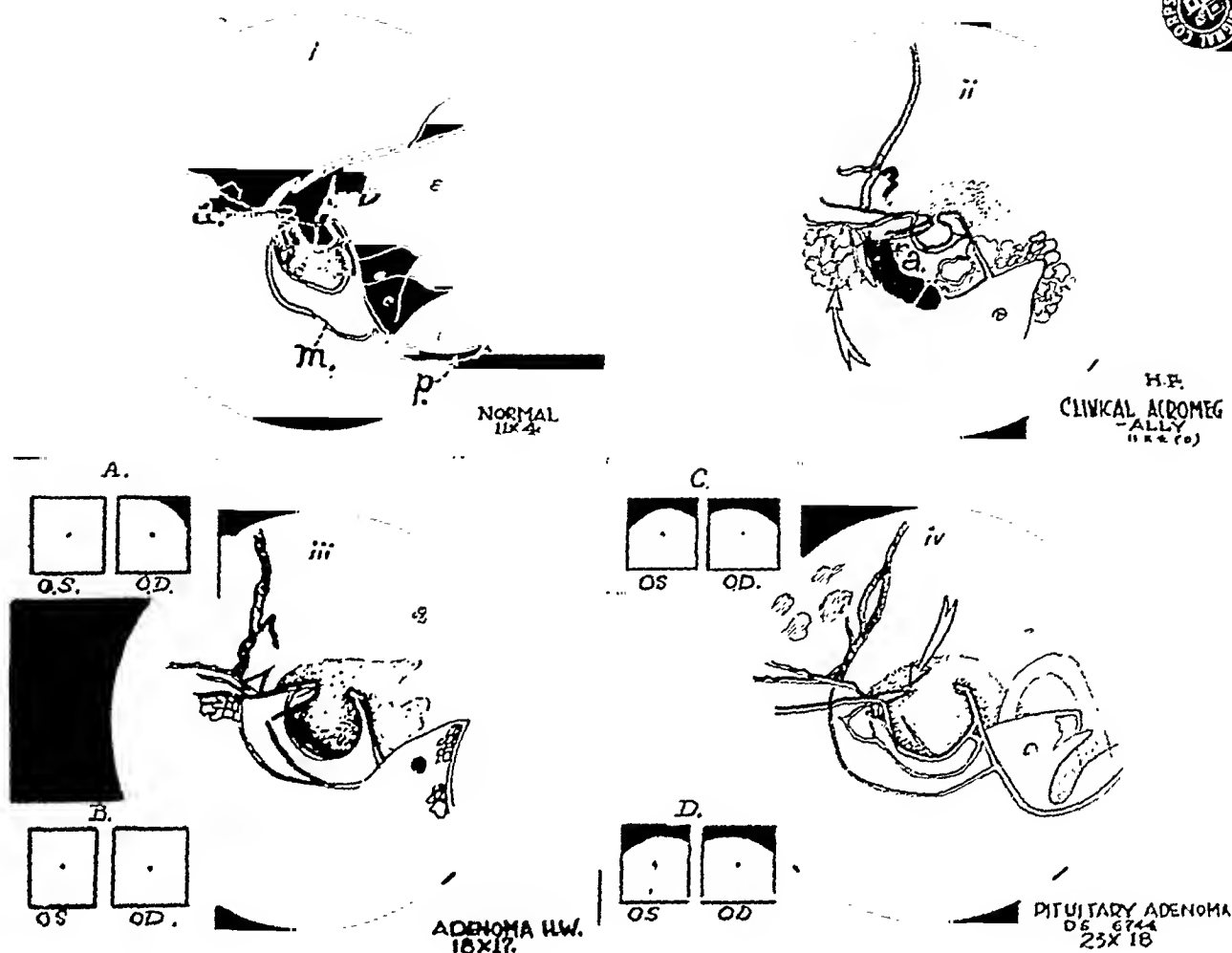


FIG. 4. *i*, upper left hand illustration showing normal anatomical relationships. At *a*, the anterior cranial fossa. At *m*, the middle cranial fossa and at *p* the posterior cranial fossa. Dotted line indicates the approximate site of the diaphragma. At *b* is seen a vascular channel on the internal surface of the squamosal portion of the temporal bone. Vascular lines at this site are often erroneously called fractures. *ii*, right upper illustration shows good example of clinical acromegaly without positive roentgen findings. Fossa measured antero-posterior 11—depth 4 mm. Because of the secondary line noted at *a* one had to consider the possibility of the adenoma decompressing itself into the sphenoidal sinus. Normal ethmoidal cells are shown at arrow. There were no positive visual field findings and libido was normal, basal metabolic rate,—13 per cent. Frontotemporal headaches disappeared following specific therapy for malaria. *iii*, twenty-seven year old Pfc. with history of weakness and anemia since 1937. Occipital headaches following otitis media. At first a diagnosis of psychoneurosis was entertained. Roentgenogram showed evidence of pituitary adenoma with fossa measurements of anteroposterior 18×depth 17 mm. Visual fields prior to therapy are shown at *A*, showing temporal quadrantic contraction on the right. *B* shows appearance following deep roentgen therapy carefully coned to the lesion. Each of three 7×7 fields received 2,000 r (air). There was marked subjective visual improvement, and the visual fields became normal. *iv*, lower right illustration. Pituitary adenoma in twenty-two year old Pfc. with history of fainting spells starting in August, 1942. Increase in size of nose and ears, spade-like hands. Since April, 1944, mild headaches, loss of eyelashes. Following deep roentgen therapy, 2,000 r (air) to each of three 7×7 fields in June and July, 1944, there was marked symptomatic improvement. Recheck of the visual fields showed no progression of the lesion. At *C* is shown the appearance of the visual fields on the tangent screen in June, 1944, with relative altitudinal defects most marked bitemporally. It is felt that roentgen therapy in this case has prevented extension of the lesion.

Rathke's pouch tumor or other pathological change in this vicinity.

OPHTHALMOLOGICAL CONSIDERATIONS

We believe that the majority of roentgenologists are well acquainted with the facts stressed by Cutler and Buschke¹⁰: "The visual fields must be regularly and carefully checked during and following irradiation and treatment interrupted as soon as noticeable impairment or further damage of the vision is demonstrated." Much credit is due our Ophthalmologic Service for the meticulous attention with which both the visual acuity and the fields of our patients have been followed.

We feel that the following, although well known, is important enough to warrant further repetition. The ophthalmological changes seen with pituitary tumors include visual field alterations, eye-ground changes, ocular palsies and disturbances due to actual invasion of the orbit. Of these, the visual field changes are the most interesting and important. Much of our present understanding of the effect of pituitary tumors on the visual fields and their interpretation is the result of the work of Walker and Cushing,³³ Traquair,³² de Schweinitz,³¹ and other pioneers in the field.

The majority of ophthalmologists use a perimeter at $\frac{2}{3}$ meter and a tangent screen at 1 or 2 meters for visual field determination. The use of colored test objects on the perimeter or small test objects on the tangent screen provides a delicate test which reveals the earliest field changes. Lowered illumination also is an aid in the early diagnosis.

The defects observed are due either to stretching, compression, or invasion by tumor of the chiasm, the optic nerves (anteriorly), or the tracts (posteriorly), these structures being injured as the result of interference with their vascular supply. Compression may be direct, by the tumor, or indirect, by adjoining structures. Grooving of the nerve by the anterior cerebral or anterior communicating artery is an excel-

lent example of the latter.²⁰ According to Jefferson,¹⁸ in the normal fixation (or usual position) of the chiasm the adenoma must rise at least a minimum of 2 cm. before causing visual symptoms. Usually roentgen evidence precedes visual field involvement. The earliest field defect observed is usually a mild contraction of one or both superior temporal quadrants with colors on the perimeter or small objects on a tangent screen; a so-called relative defect (Fig. 4, A). If the case is typical, and allowed to progress, the changes may continue until a bitemporal hemianopsia develops and becomes more and more nearly absolute with the passage of time, one side usually progressing more rapidly than the other. Not infrequently, however, the field change is more bizarre and may take on one of a number of forms representing involvement of one optic nerve, or one tract or a combination of either of these with a chiasmal defect in addition. Among these one sees not infrequently a homonymous defect, usually asymmetrical, at times associated with central visual field involvement, i.e. a central scotoma or blind spot. One may also see unilateral blindness with a defect in the other field or possibly, nasal or temporal hemanopia with or without a defect in the contralateral eye, and so on. The above findings all depend upon whether the area affected is the optic nerve, the optic tract, the chiasm or a combination of these parts.

The ophthalmologist can usually state that the field change indicates the presence of a prechiasmal, chiasmal or postchiasmal tract lesion. By the nature of the defect, by which is meant its relative or absolute quality, its mode of onset and progression, one often, with fair certainty, can differentiate between tumor, vascular lesion and one of inflammatory or degenerative origin. In differentiation one must consider aneurysm, basofrontal tumor of other than pituitary origin as meningioma, Rathke's pouch tumor, or chiasmal arachnoiditis, retrobulbar neuritis, syphilis and other inflammatory lesions. Aneurysm in the region

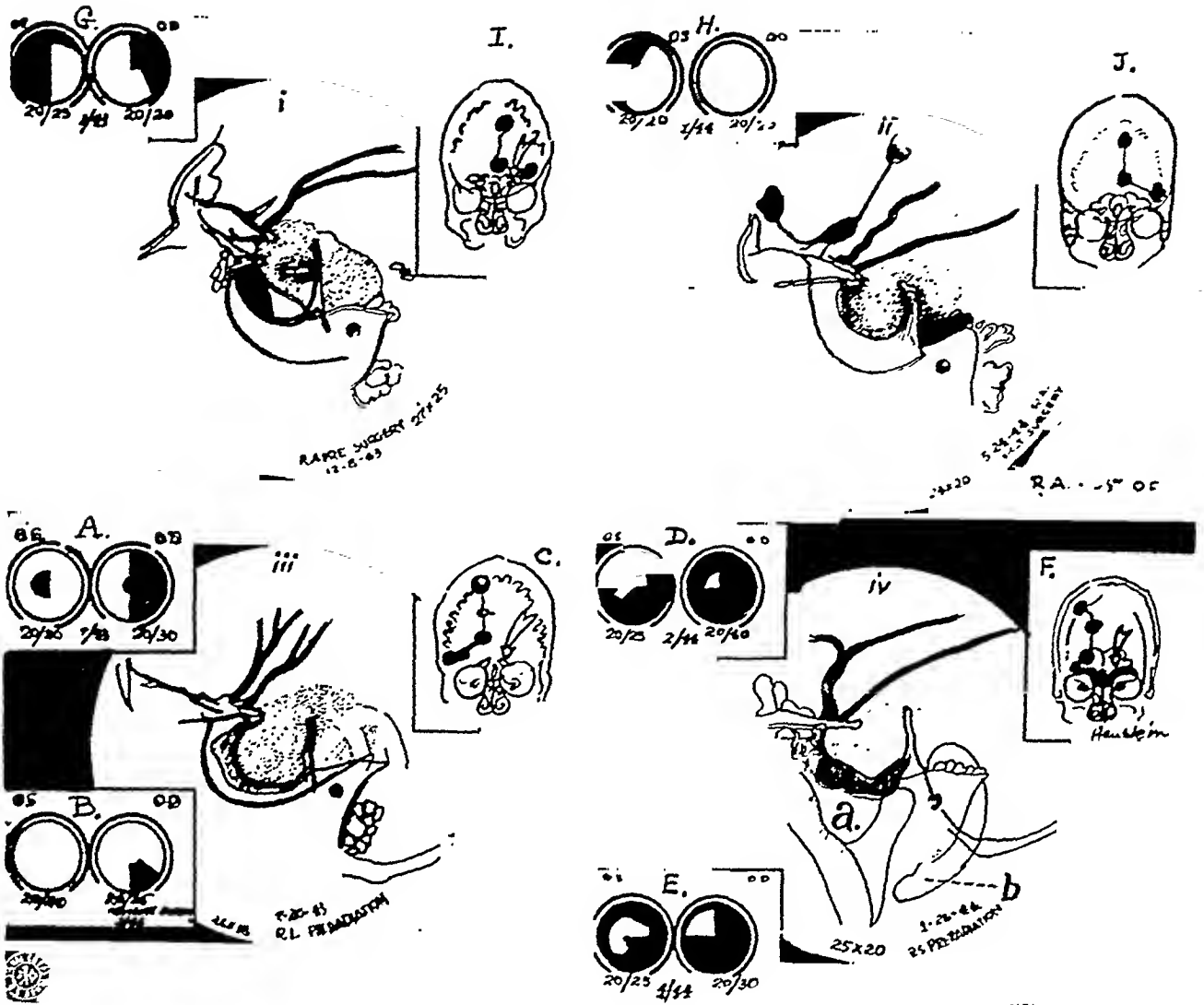


FIG. 5. *i*, left upper illustration shows typical adenoma of the pituitary in a thirty-eight year old officer, with history of blurred vision of the outer half of the left eye since May, 1943, bilateral frontal headaches and difficulty reading fine print. Patient operated on January 21, 1944. A vascular type of adenoma was removed. Postoperative roentgen therapy had to be curtailed because of persistent wound infection. Roentgenogram made four months after surgery (*ii*) shows marked improvement in the appearance of the sella turcica which measures 24×20 mm. compared with previous measurements of anteroposterior $27 \times$ depth 25 mm. Improvement in the visual fields due to surgery alone is shown graphically in G (pre-operative visual fields) and H (postoperative visual fields). In G is seen a bitemporal hemianopsia which is relative in the right eye. Fundusoscopic examination showed mild pallor on the right and moderate pallor on the left with loss of substance. Lower left illustration (*iii*), twenty-five year old Pfc. with history of fleeting headaches and failure of lateral vision which was noticed when he was in close-order drill. Note the scalloped appearance of the ventral wall of the dorsum sellae apparently the result of a bilobed tumor. Eye consultation suggested possible ventricular involvement.

Between July 24 and September 23, 1943, he received 2,600 r (air) to each of three fields, cross-firing the lesion. There was marked temporary improvement following therapy, but later vision failed and it was felt that cystic changes might be taking place. A craniotomy was therefore carried out on December 13, 1943, by Lt. Col. Frank H. Mayfield. A shows the appearance of visual fields prior to roentgen therapy with, absolute temporal scotoma in the left eye and absolute hemianopsia on the right with a relative central scotoma. Postoperatively full vision was obtained on the left side and on the right there was an absolute inferior quadratic defect which was thought likely to be the result of compression of the chiasm from above by the anterior cerebral artery. Funduscopy showed pallor, mild on the left and pallor, moderate on the right side. C, F, I, and J show the appearance of the anterior clinoids in each case.

Lower right illustration (*iv*), pituitary adenoma in patient aged twenty-nine. History of frontal headaches, polyuria and gain of weight starting in October 1942. Twelve months later marked optic atrophy and bitemporal hemianopsia. Patient was operated on fourteen months after onset of symptoms. At operation the optic nerves were found stretched over the tumor capsule. There had been no subjective failure

of the sella, sclerosis of the internal carotid arteries in older people, third ventricle dilatation, all may be suggested by field defects.

When a progressive chiasmal lesion is suggested by field examination and the pituitary fossa is normal by roentgen study, the diagnosis of aneurysm must be considered. This is especially true when craniotomy is contemplated, for success of surgery is often dependent on previous suspicion of and preparation for the management of such a lesion.

Ophthalmoscopic changes occur in the form of primary optic atrophy. Early the discs appear normal, later pallor is noted, and still later loss of substance and secondary generalized retinal arterial narrowing. These latter changes usually indicate permanent damage of some degree. *Choked discs are rarely seen and then only with large tumors where the ventricular system is impinged upon or the foramen of Munro obstructed.*

Partial or complete involvement of the third, fourth and sixth cranial nerve also may occur with lateral extension of the tumor from the sella. Involvement of the sixth nerve is the least common. Third nerve palsy may be complete with ptosis and divergence, or mild, with weakness of only one or two muscles. Rarely, there may be actual invasion of the orbit by tumor.

Interpretation of the visual field findings usually throws some light on the severity of the damage done, the degree of improvement following irradiation and surgery, and offers as well, a delicate means of evaluating the effectiveness of therapy. An excellent example is one of our cases, R. L., whose seller changes are shown in Figure 5, *iii*. Following preoperative roentgen therapy (2,600 r to each of three 7×7 cm. fields),

there was marked improvement in the visual fields. By persistently reviewing the fields we were then able to demonstrate a decrease in the seeing areas. This led us to believe the patient might be developing a cyst. Transfrontal craniotomy was carried out by Lt. Col. Frank H. Mayfield. Marked improvement in vision followed with only a small residual absolute defect demonstrable in the right field. This is shown

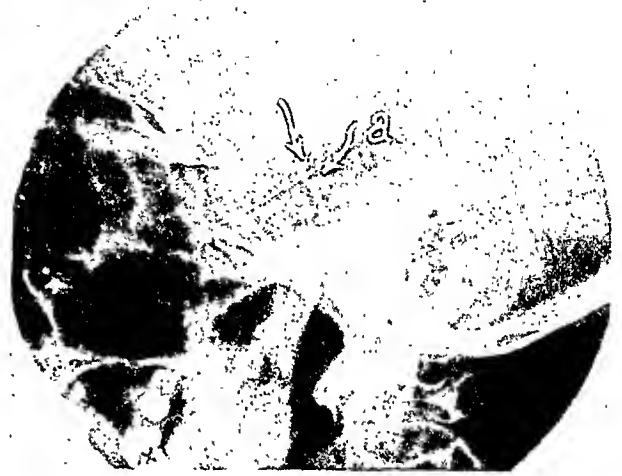


FIG. 6. Characteristic appearance of the hypophysial fossa in patient with pituitary adenoma (same case as Fig. 5, *iv*). The thinned and apparently elongated dorsum sellae is shown at *a*.

graphically in Figure 5, *B*. Cusick⁹ has directed our attention to the fact that if marked damage has already occurred with only small remnants of the fields remaining even more consideration must be given to the choice of treatment, i. e. whether to use deep roentgen therapy or surgery, for sudden alteration in the physiology or transient edema of the optic nerve or chiasm may lead to further damage. This effect might be compared to the sudden blindness following decompression of the eyeball

of vision, but marked constriction of the right visual field and moderate constriction of the left as shown in *D*. The patient received in February and March, 1944, 1,700 r (air) to each of three fields, cross-firing the hypophysial fossa, with the resultant improvement shown in *E*. *E* shows a concentric inferior and altitudinal contraction, left. Temporal hemianopsia, inferior nasal quadrantopsia and concentric contraction, right. Funduscopic examination shows pallor severe, right disc, with loss of substance. Moderate pallor on the left. Mild secondary narrowing of the retinal arterioles.

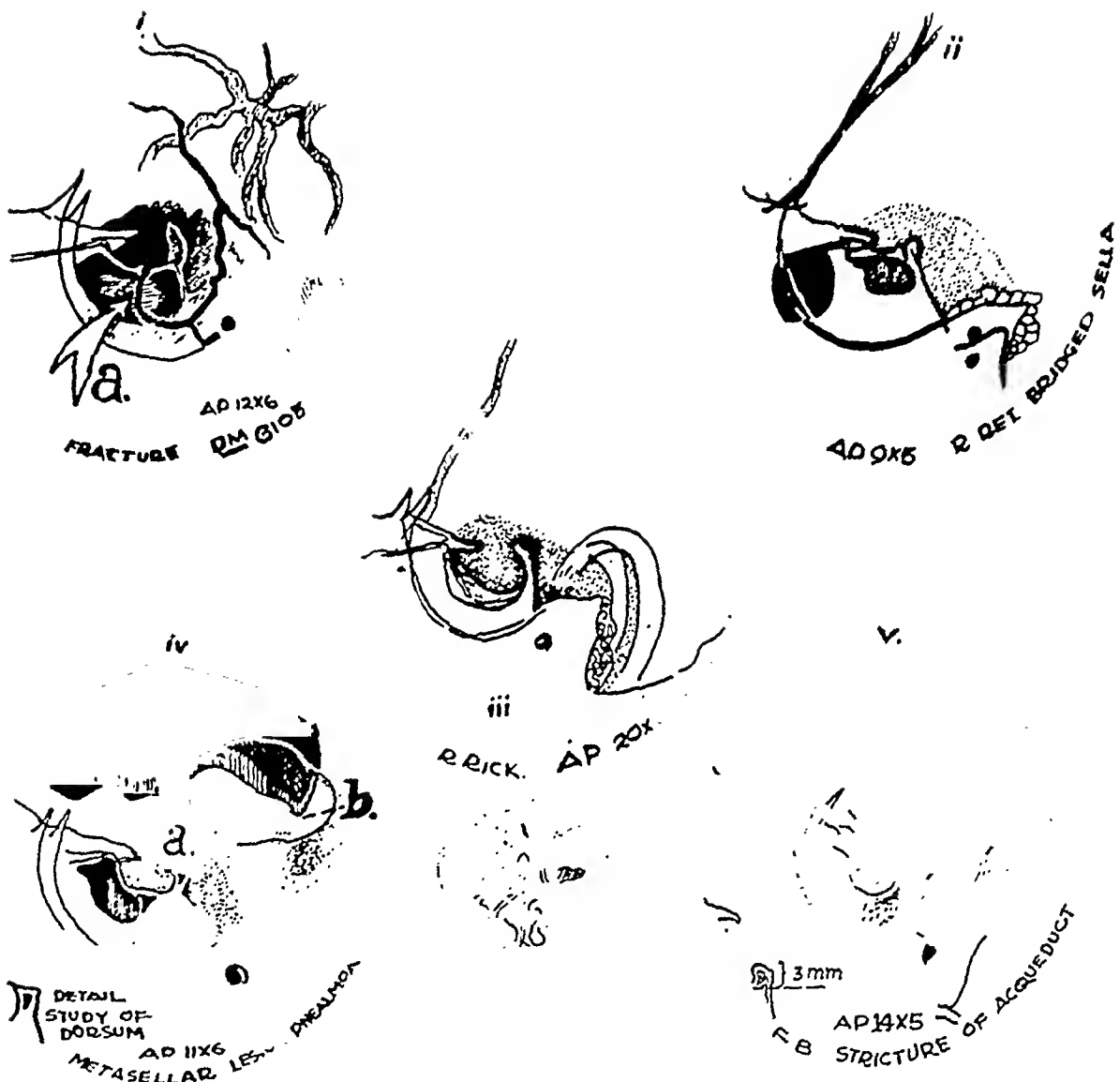


FIG. 7. *i*, left upper illustration shows fracture involving the middle cranial fossa and floor of the pituitary fossa, at *a*. This soldier was severely injured in an automobile accident while on authorized pass. After he recovered consciousness the fracture shown above was demonstrated. He had involvement of the right fifth, sixth and seventh cranial nerves with incomplete recovery which necessitated tendon transplant to the insertion of the external rectus muscle in order to allow for external rotation of the globe. Right upper illustration (*ii*) shows a normal bridged sella measuring 9x5 mm. for comparison with abnormal hypophyseal fossas as shown below (*iii*). Middle illustration shows appearance of hypophyseal fossa of patient with malignant adenoma of the pituitary gland. Note the double contoured floor. Fossa measured antero-posterior 20x depth 10 mm. Insert below the illustration shows normal left anterior clinoid at *a*. The right anterior clinoid was missing. Left lower illustration (*iv*) shows appearance of the hypophyseal fossa in patient with large pinealoma. The dorsum sellae is eroded from above and its superior margin is relatively concave and sharpened anteriorly. Large pinealoma shown at *b*. Third ventricle shown at *a*. Right lower illustration (*v*)—similar appearance due to an extrasellar lesion caused by stricture of the aqueduct. The third ventricle is shown at *a*. The upper end of the stricture is shown at arrow. Note that the vertical dimension of the dorsum sellae is only 3 mm.

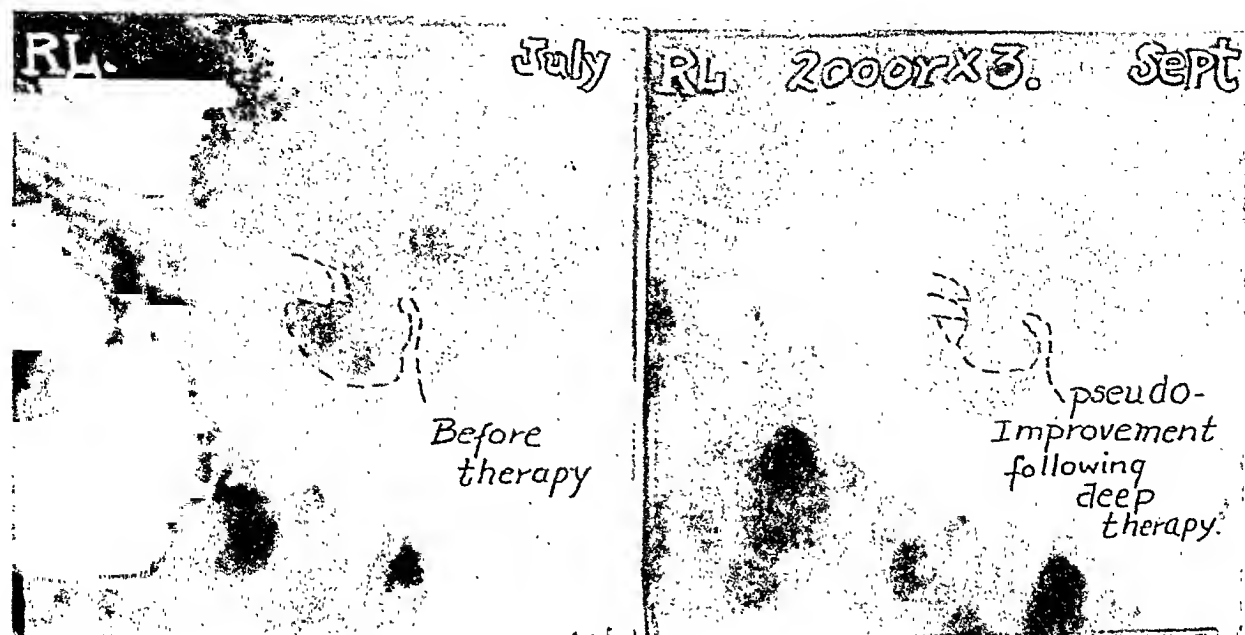


FIG. 8. Effect due to slight differences in the technique employed. Illustration on left shows the appearance of the pituitary fossa before therapy. Right hand illustration shows pseudo-improvement following deep roentgen therapy amounting to 2,000 r (air) to each of three 7×7 fields, cross firing the pituitary fossa. Additional roentgenograms made at a later date show the improvement was not real, but only apparent.

when the optic nerve has suffered previous severe damage from glaucoma.

The changes produced on the visual field by irradiation, surgery, or a combination of both, are often dramatic and especially gratifying in view of the fact that visual symptoms are often the principal reason for treatment.

CHANGES IN THE PITUITARY FOSSA RESULTING FROM ADENOMA

During the years 1943-1944 six cases of pituitary adenoma were treated in the Percy Jones General and Convalescent Hospital, Roentgen Therapy Department. As indicated heretofore, pituitary measurements showed the fossas grossly enlarged, the average size being anteroposterior 23×depth 17 mm. In only 1 instance was the pituitary fossa slightly smaller (20×10 mm.). In the latter we suspected from the roentgen evidence that we were dealing with an intra- as well as an extrasellar lesion. This diagnosis was confirmed subsequently at necropsy.

Changes affecting the pituitary fossa as the result of various diseases are shown in

Table II—slightly modified from Kornblum.¹⁹

The characteristic roentgenographic findings of hypophysial adenoma are well known, but certain diagnostic features are worth re-emphasis.

1. Uniform and general enlargement of fossa with ballooned appearance.
2. Ventral wall of dorsum smoothly eroded, or even scalloped in outline suggesting the presence of a bilobed tumor (Fig. 5, *iii*).
3. Dorsum often displaced posteriorly and apparently elongated, as result of actual deepening of the fossa (Fig. 6).
4. If eccentric in position, adenoma may cause erosion of the ipsilateral anterior clinoid (Fig. 7, *iii*).

TABLE II

- I. Intracellular lesions, such as pituitary adenomas.
- II. Extrasellar lesions.
 - a. Suprasellar, as by a Rathke's pouch tumor, or olfactory groove meningioma.
 - b. Parasellar, as by an aneurysm of the circle of Willis, or laterally placed neoplasm.
 - c. Metasellar lesion, as by a small or large tumor obstructing the aqueduct and causing hypo-

physial erosion by an enlarged and pulsating third ventricle.

- III. Changes due to sphenoidal sinus disease.
- IV. Changes due to other conditions such as:
 - a. Metastatic malignancy, multiple myeloma (Fig. 13).
 - b. Chordoma, xanthomatosis, etc.

Camp considers the above a rare occurrence, but both anterior clinoids should be inspected with care. Attention has also been directed to the fact that once the dorsum has become demineralized, due to pressure changes, normal restoration of calcium salts cannot be expected. Dyke's case, S. F., a female, aged thirty-nine, demonstrates that recalcification can and does take place. Such reossification may be relatively permanent over a period of years. It should be recalled that reconstruction of the sella not infrequently occurs following deep roentgen therapy of nasopharyngioma.^{23,24}

Close attention to roentgen technique is imperative, otherwise effects are seen which may cause confusion in diagnosis. This is demonstrated in Figure 8. Following 2,000 r (measured in air) to each of three 7×7 cm. fields improvement in the configuration of the hypophysial fossa was observed. Further serial roentgenograms, however, indicated that the improvement was not real, but resulted from slight differences in the projection of the central ray. In this regard it is worth remembering that lateral stereoscopic roentgenograms should be made of each side in order to obtain a maximum of information. This is particularly true when the possibility of a parasellar lesion is being considered.

In the condition known as acromegaly three types of sellar changes are described:²⁵

1. No fossa enlargement or minimal enlargement, but possibly with increased bone condensation changes in the calvarium.
2. Typical ballooned appearance, but showing dorsum often thicker and denser than normal.
3. Extensive destruction as the result of an advanced or malignant type of acido-

philic adenoma. This type is differentiated from extrasellar lesions with difficulty.

Additional roentgen findings in support of the above diagnosis are:

1. Prominence of the supraorbital ridges.
2. Hyperpneumatization of the paranasal sinuses.
3. Hypertrophy of the mandible with malocclusion of the jaws and wide spacing of the teeth.
4. Tufting of the ungual tuberosities (distal phalanges).

Regarding changes in the hands, Holt and Hodges¹⁷ state: "the roentgenographic appearance of the hands in acromegaly is so characteristic that the presence of a pituitary eosinophilic adenoma may be suspected even in the absence of intrasellar erosion. Large broad spade-like hands with overgrowth of the terminal phalangeal tufts, prominence of bony protuberances along the shafts of metacarpals and phalanges and a peculiar soap-bubble pattern of distorted trabeculae in the bone ends comprise the changes commonly encountered."

Parasellar lesions are relatively infrequent and often diagnosed with difficulty. Such a lesion may be suspected by a double-contoured sellar floor. In order to exclude improper technique causing this appearance, the anterior clinoids should be superimposed. Moreover, even in the normal skull the two sides are not necessarily absolutely identical, so that careful correlation of all clinical facts is advisable. Any bizarre appearance of the hypophysial fossa, or a roentgen picture not consistent with diagnosis of adenoma should bring to mind some form of extrasellar lesion, either in the para- or metasellar position. Recently a curious appearance of the hypophysial fossa with double floor, ipsilateral clinoid erosion, and demineralization of the dorsum out of proportion to the size of the sella, led us to suggest a combined intra- and extrasellar tumor (Fig. 7, *iii*, and 9). The history follows:

A soldier, aged thirty-seven, was admitted to Percy Jones General and Convalescent Hospital in November, 1944, complaining of blurred

vision of thirteen months' duration. For two months he had been unable to read news type. The patient recalled five changes of glasses by five different physicians since December, 1943. Recently he had noted intermittent severe frontal morning headaches and inability to see people approaching from his left. In July, 1944, he was admitted to a hospital where diagnosis of a pituitary tumor was made. He was referred to our hospital for deep roentgen therapy.

Physical examination revealed an obese soldier, 5'8" tall; visual field examination showed an absolute left homonymous hemianopsia with concentric contraction and right central scotoma; ophthalmoscopic examination revealed pallor, grade 1—temporally, both discs. Diagnosis: Field change due to a combined chiasmal and tract lesion on the right side.

Roentgen examination revealed an enlarged fossa with a hazy double floor and demineralized dorsum. The sella was not characteristically ballooned. It suggested possible extrinsic pressure by a meta- or parasellar lesion (Fig. 7, *iii*). There was no evidence of increased intracranial pressure. Roentgen conclusions were as follows: "Enlargement of the pituitary fossa plus demineralization of the dorsum sellae. The changes found suggest a parasellar rather than an intrasellar lesion. However, as has been noted by Kornblum, occasionally a pituitary tumor will rupture to the exterior and cause changes suggesting a parasellar erosion."

In this case carcinoma and chordoma, though less likely, could not be entirely excluded. Because of the visual field findings, operative exploration was performed through a right temporal bone flap, by Lt. Colonel Frank H. Mayfield. "The dura was incised along the sphenoidal ridge which brought into view the chiasmal area. There was a purplish tumor mass protruding to the right of the right optic nerve, compressing it, and displacing the right internal carotid artery lateralward. There was an additional extension of this purplish mass projecting upward between the anterior fork of the chiasm. The posterior portion of the chiasm was not exposed at this time. The tumor obviously contained fluid and considerable difficulty was encountered determining whether or not this was an aneurysm or cystic neoplasm. By aspiration, it was proved to contain in certain areas brownish cystic fluid, and so removal was begun. That portion lateral to the right optic

nerve was excised uneventfully. The capsule of the tumor between the optic nerves was then excised and removal begun with pituitary curet. Approximately three scoopful had been removed when a massive hemorrhage occurred from the perisellar area. It was believed that either the internal carotid artery on the left or an aneurysm of circle of Willis had ruptured. Immediately the brain swelled so that exposure was no longer possible; however, it was possible to control the hemorrhage by applying pressure with the index finger to the left lateral portion of the sella, and with difficulty a large piece of fibrin foam, immersed in thrombin, was applied in this region and held for fifteen to twenty minutes, after which it was possible to remove the finger without additional visible bleeding. The brain was extremely tense and the inferior portion of the frontal pole was lacerated considerably in an endeavor to obtain exposure after hemorrhage ensued. Amputation of the frontal lobe was contemplated, but inasmuch as the bleeding was controlled, it was not considered that the patient's condition would be improved by re-exploration of the field." No further procedure was deemed advisable and the incision was closed as rapidly as possible. Despite supportive treatment consciousness was never regained. The temperature rose to 107° F., the pulse to 160, respiration became labored and death occurred twenty-four hours later.

Necropsy was performed by Major S. E. Moolten and the following is a short abstract of the anatomical diagnosis rendered:

1. Invasive chromophobe adenoma (malignant chromophobe adenoma) of anterior lobe of pituitary (Fig. 9A and 9B).
2. Pressure necrosis of anterolateral branch of left middle cerebral artery, secondary to 1.
3. Massive arterial hemorrhage, subarachnoid, secondary to 2.
4. Extensive erosion and atrophy of right anterior clinoid process.
5. Compression atrophy of both lobes of the pituitary as well as the optic nerves and optic tracts (Fig. 9C).

In the genitourinary system were found congenital cysts of the kidneys, a medullary fibroma of the left kidney and fetal lobulation. A chondroepithelial hamartoma (congenital dislocation tumor) was found in the thyroid.

Moolten's discussion of the above findings is pertinent. His comment is presented here in detail:

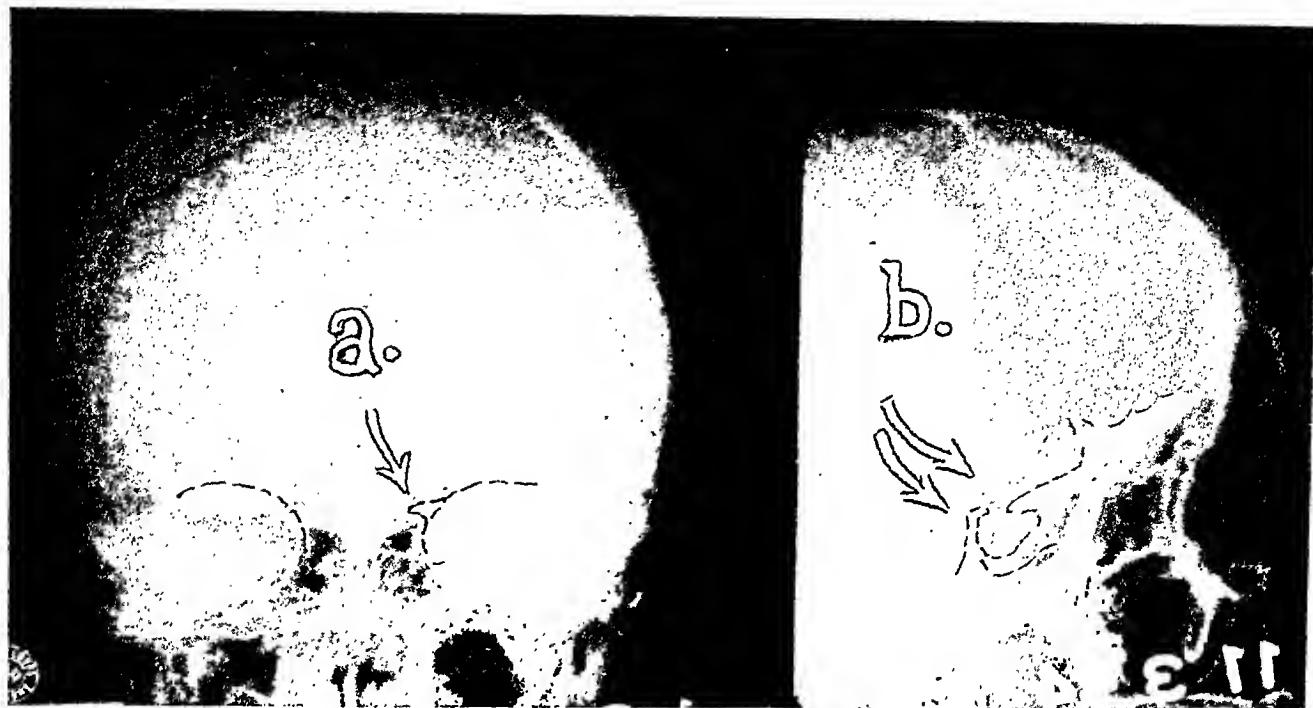


FIG. 9. Illustration showing normal left anterior clinoid at *a* and peculiar configuration of the sella turcica at *b* with double contoured floor (see Fig. 7, *iii*).



The association of a pituitary adenoma with benign tumors of other organs in this same case may not be entirely fortuitous. The medullary fibroma of the kidney is the classical example of hamartoma, i.e., congenital malformation or tissue combination and is probably the paradigm of most benign tumors. In the same category, the congenital cyst of the kidneys and the hyalinized cavernoma of the liver may be included, and, in all likelihood, also the leiomyoma of the cardiac end of the stomach. All these manifestations of tissue malformation may be part of a disseminated hamartial tendency which, although of minor degree, may nevertheless be underlying to the development of the pituitary adenoma (cf. frequent association of chromaffinoma and multiple neurofibromatosis).^{15,22}

The rapid growth of the pituitary tumor, its extensive invasion of surrounding bone and other tissues, its marked vascularity, and its highly cellular composition are features which are somewhat unusual, in ordinary chromophobe adenoma. For these reasons the diagnosis suggested is malignant adenoma of the chromophobe cells which, as summarized by Bailey and Cutler¹ "differed clinically

FIG. 9A. View of the internal aspect of the cranium showing large pituitary tumor in situ at *a* lying slightly to the right of the midline. Compressed left optic nerve is shown at *b*. One can readily see from this illustration why the right anterior clinoid was eroded. Photomicrograph below shows cells of malignant adenoma at *a* causing erosion of bony trabecula at *x*. Dura is shown at *c*.

from the usual case of benign chromophobe adenoma in the history of rapid progression of symptoms, and and in the rapid extension of the tumor into the skull bones adjacent to the sella turcica, the neighboring brain substance and the nasopharynx. . . . Histologically the tumors were characterized by arrangement of the tumor cells in broad sheets separated from one another by a stroma which is altered in character from that of the normal pars anterior and was in part derived from structures at the edge of the tumor, far from the sella turcica. . . . The term 'malignant chromophobe adenoma' indicates that they are locally invasive and possess certain of the histologic characteristics of malignant tumors, but do not metastasize either in the cerebrospinal axis or elsewhere in the body. . . . The tendency of the malignant chromophobe adenoma to include large blood vessels in the sellar region makes surgical approach to it especially perilous!"

In metahypophysial (metasellar) lesions Pendergrass states: "It is not always possible to distinguish with any degree of certainty, between sellar deformity of intra- and extrahypophysial erosion. To make a diagnosis requires careful consideration of

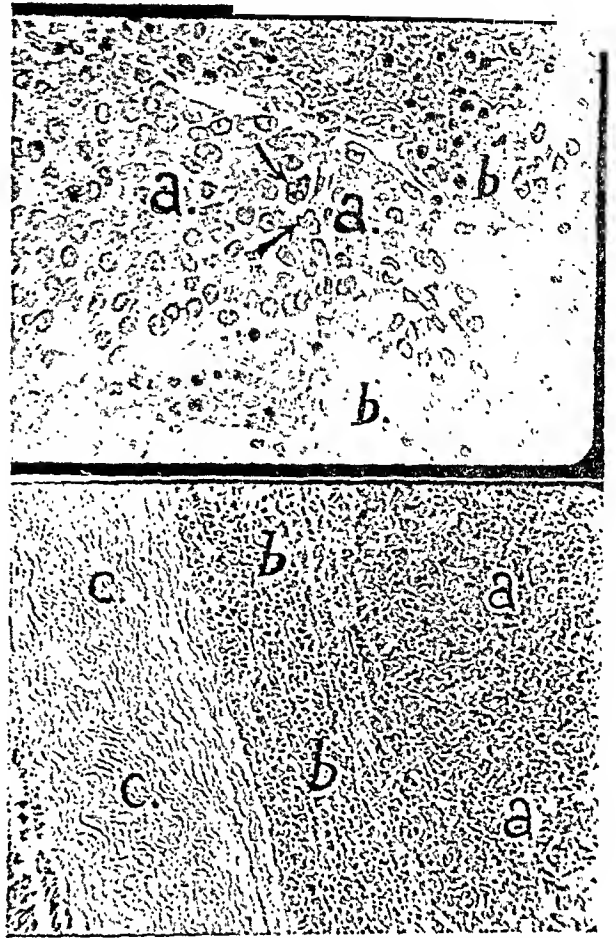


FIG. 9C. Photomicrograph showing appearance of neoplasm under high and low power. In the upper illustration a nest of tumor cells is shown at *a-a*, and hyperchromatic nuclei are indicated by arrows. The dura at *b-b* is being invaded. The lower illustration shows malignant adenoma at *a* compressing normal pituitary cells at *b*. Normal dura is seen at *c*.

all findings and sometimes cerebral pneumography in addition."²⁶ The correct diagnosis is often suggested, however, when the dorsum becomes ragged and thin and appears eroded from above. Camp,⁶ in 1924, showed that the pressure of the third ventricle from above produces widening and flattening of the sella. He states: "Since the pressure is transmitted solely from above, the posterior clinoids are eroded from above rather than anteriorly and they become shortened and pointed rather than narrowed and thinned." In Figure 7, *iv* and *v*, are shown two good examples of transmitted pressure. The first is a twenty-nine year old nurse⁵ who complained of

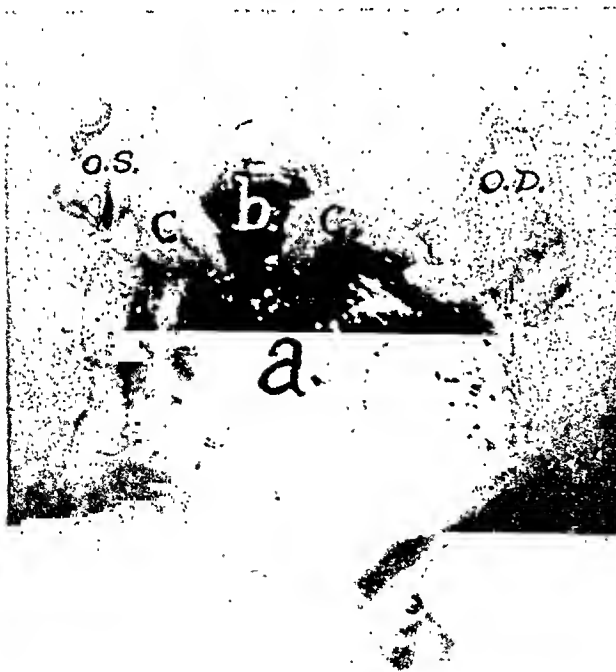


FIG. 9B. This is a detailed illustration of pituitary tumor shown in Figure 9A. The major portion of the malignant adenoma is shown at *a*. The forward extension of the tumor is seen at *b*. The right and left optic tracts are considerably distorted and are shown at *c-c*, and the right and left optic nerves are well shown, O.D. and O.S.

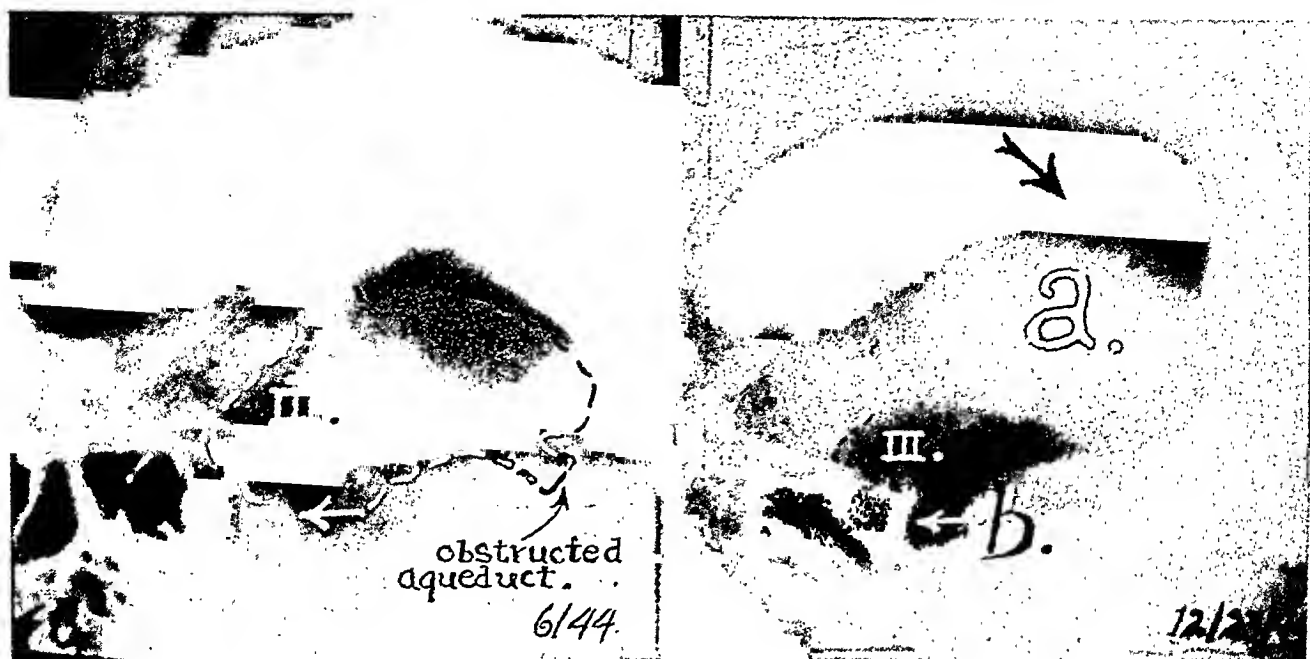


FIG. 10. Ventriculograms showing erosion of the dorsum from above by an enlarged third ventricle. The left illustration shows a huge dilatation of the third ventricle due to fibrous stenosis of the aqueduct and nodular ependymitis. The right hand illustration shows dilatation of the third ventricle as result of large pinealoma at *a*. The erosion of the dorsum is well shown at *b*. This film was obtained with the aid of the cassette supporting arm devised by Bell,⁴ and is an example of the type of film routinely obtained with this apparatus



FIG. 11. Illustration shows a large cystic astrocytoma in the left frontal region beautifully outlined by injected air. The mural nodule is shown at *a*. The cyst is self evident. The right lateral ventricle is shown at *b* and is markedly displaced to the right. The dorsum of the hypophysial fossa is demineralized. The anterior clinoids are normal. History: Severe intermittent right frontal headaches, blurred vision, and projectile vomiting. Tumor Board decided against therapy as mural nodule had been completely removed.

severe occipital headache and vomiting of two months' duration. Air study showed marked hydrocephalus from a large oval pinealoma (at *b*). The second case (Fig. 7, *v* and 10) shows a stricture of the aqueduct in a twenty-two year old patient. This patient, a possible angle tumor suspect, had onset of symptoms three years before admission with "blind staggers" and dizziness. Physical examination showed bilateral di-

7, *iv*). A third case, a large frontal cystic astrocytoma, produced no erosion or thinning of the anterior clinoids as might be suspected, but caused a high degree block of the iter with erosion of the dorsum from the posterior aspect, presumably as the result of posterior displacement of the third ventricle with kinking of the aqueduct (Fig. 11).

An example of a lesion which will oc-

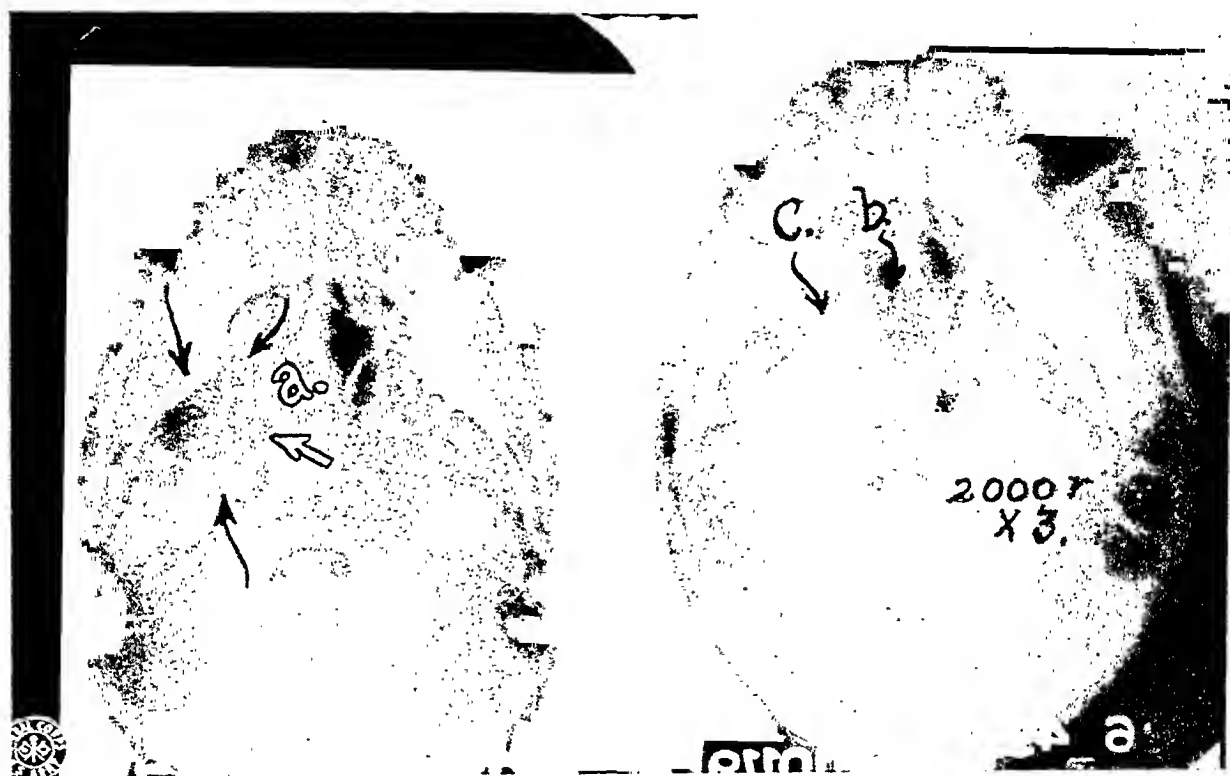


FIG. 12. Case of nasopharyngioma showing, on the left, a large destructive lesion at the base of the skull near the pituitary fossa. The left sphenoidal sinus is shown at *a* and is hazy due to the infiltration by new growth. Following heavy roentgen therapy partial healing of the lesion is seen at *c* and complete clearing of the left sphenoidal sinus is shown at *b*. This improvement followed 2,000 r (air) cross fired into the lesion through each of three separate fields.

plopia and diminished sensation of the left half of the body. Necropsy performed on January 26, 1944, showed severe internal hydrocephalus, secondary to stenosis of the iter plus a granular ependymitis. Roentgenograms of the hypophysial fossa of both patients show marked shortening of the dorsum as compared with the vertical dimension of the anterior fossa wall, and in the first instance there was a definite cupping of the upper or superior margin of dorsum as shown in the detail study (Fig.

casionally cause destruction of the sella turcica is shown in Figure 12. In this instance a destructive lesion due to a nasopharyngioma, also known as a lymphoepithelioma, was found in the floor of the middle fossa in the left parasellar region. The dorsum sellae, however, was intact. The changes described could only be shown by making stereoscopic roentgenograms in the Bowen-Hirtz or submentovertex projection. A brief history follows:

A colored private, aged twenty, was admitted

to Percy Jones General and Convalescent Hospital Therapy Department with a history of pain in the left facial region of eleven weeks' duration. No history of tinnitus or nasal obstruction was elicited. On examination made at another hospital a mass had been found beneath the angle of the left mandible, and biopsied. Diagnosis of reticulum cell sarcoma was made and subsequently confirmed by the Army Medical Museum. When first seen, the patient complained of severe distress in the region of a

encountered by the examining finger and were also seen on postnasal mirror examination. The patient was found to have a conduction deafness on the left side.

Diagnosis: Nasopharyngioma.

Carcinoma of the hypophysis occasionally occurs and is similar to cancer in other parts of the body. No typical appearance is seen aside from irregular destruction which may involve any portion of the sella turcica

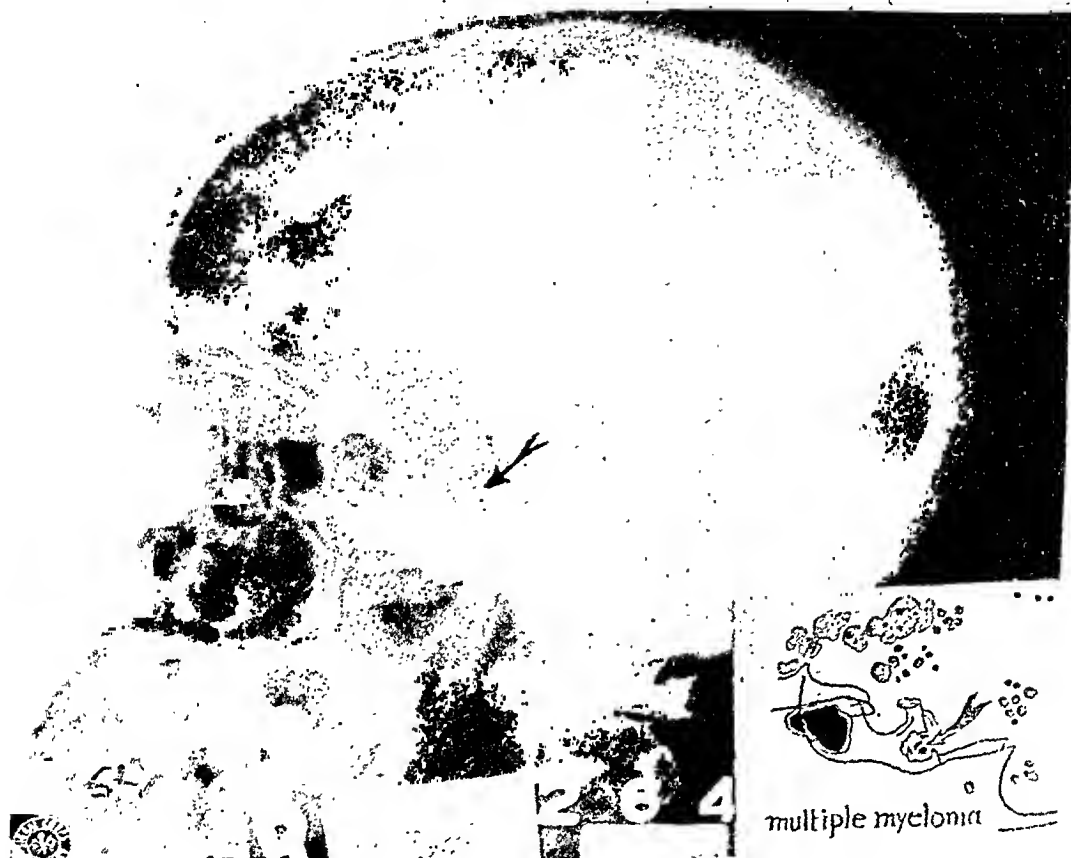


FIG. 13. Destructive lesion of the clivus due to multiple myeloma. Because of prominence of lesions in the calvarium changes in the region of the pituitary fossa are readily overlooked.

well healed biopsy scar, but no significant lymphadenopathy was palpable in the left cervical region. The patient complained of severe lancinating pain in the left retroorbital region. Roentgenograms showed widespread infiltration of the middle cranial fossa indicated at *a*, Figure 12. The roentgen picture was characteristic of metastatic nasopharyngioma. Provisional diagnosis was confirmed by the Nose and Throat Section after nasoscopic examination by Lt. Colonel C. W. Barkhorn. A mass was palpable behind the posterior pillar of the left tonsil. This extended upwards to the eustachian tube orifice. Edema and swelling were

and adjacent osseous structures.²⁶ The fossa often shows no evidence of enlargement, except possibly for slight deepening of the floor. Interestingly enough, Camp⁶ has described destruction of the sella by metastatic disease from carcinoma of the breast and even from sarcoma originating in the retroperitoneum.

During the last year (1944) 360 cases of malignant disease have been treated in the Percy Jones General and Convalescent Hospital, Department of Roentgen Therapy. These represent, for the most part,

young adult patients. Seventy-nine of these (21.9 per cent) have had manifest evidence of metastatic disease. Few, however, have shown evidence of osteolytic change in the cranium. So far, destruction of the sella has occurred in only one individual. This patient has multiple circumscribed translucent areas involving the entire skeletal system. The roentgen picture is characteristic of multiple myeloma. The changes in the sella are unimportant clinically, but might readily be overlooked (Fig. 13). The following is a brief history:

A private, aged thirty-one, was admitted with history of chest and shoulder pain since January, 1944. He had "drawing pains" in the chest, and loss of appetite. Sternal biopsy by Captain W. E. Peltzer revealed specific myeloma cells. Interesting laboratory findings are as follows:

1. Increase in total protein, which at one time reached 12.2 mg. per 100 cc.; 7.6 glob./4.6 alb.
2. No Bence-Jones proteinuria (50 per cent or less do not have a positive test).
3. Calcium as high as 19.1 mg.
4. Creatinin 3.4 mg. thought to be due to renal damage.
5. Elevated sedimentation rate, 44 mm. in 60 minutes.
6. Elevated blood cholesterol, 405 mg. per 100 cc.

Patient has shown striking improvement with roentgen therapy to entire body¹³, plus conventional irradiation to other areas as symptoms demanded. The lesions in the cranium have regressed slightly with heavy roentgen therapy (2,000 r, air, to each of two large fields). It would appear that the lesions though controlled are relatively radioresistant.

Aneurysms of the circle of Willis will, if large enough, cause marked sellar deformation, and give rise to symptoms identical with those of pituitary tumor. Presumptive diagnosis can be made by finding curvilinear streaks of calcification in the aneurysmal sac on conventional roentgenograms. This must be differentiated from sclerosis without aneurysm which is usually asymptomatic. The latter is manifested by double striae of calcific density on a level with or

just above the corticoclinoid foramens. There is a convex upward curve representing the arch of the carotid "siphon." By contrast, ossification of the interclinoid ligaments is likely to present a flat or concave superior border, lying more or less in the plane of the diaphragma. These linear areas of sclerosis may be projected over the internal aspect of the orbit in conventional posteroanterior studies, as indicated by Dyke.¹² For accurate localization of aneurysm, however, the method of choice

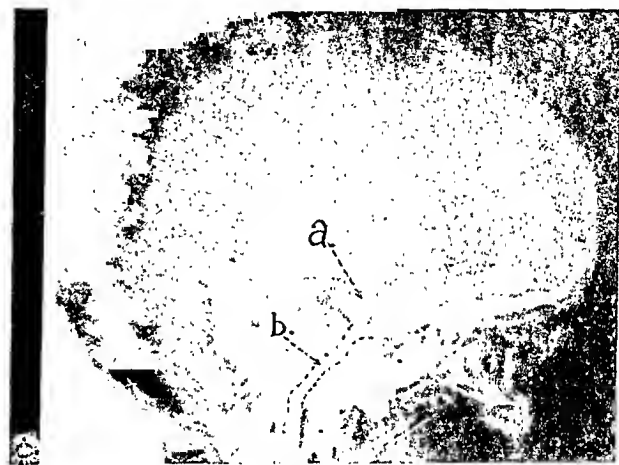


FIG. 14. Illustration showing aneurysm of the circle of Willis. Aneurysm at *a* and carotid siphon at *b*. Arteriogram was obtained after injection of diodrast into common carotid artery. (Courtesy W. B. Scoville, M.D.)

is that introduced by Egas Moniz in 1927. An excellent example of the accuracy with which such a lesion can be outlined is shown in Figure 14. A large aneurysm may cause hemiplegia due to pressure on the crus cerebri, congestion of the eye due to compression of the cavernous sinus, and severe headache due to leakage of blood into the subarachnoid space with resulting meningeal irritation. According to Pendergrass, "the opportunities for obtaining characteristic roentgen evidence are comparatively few."²⁶ This statement is significant since aneurysms of the circle of Willis are, for the most part, symptomless or silent except when they rupture. In this event the symptoms or signs are quite characteristic, causing ptosis, diplopia, pain

over the forehead and, as mentioned above, signs of acute subarachnoid hemorrhage. The diagnosis and localization of these lesions in intervals between hemorrhages usually requires angiography. Many patients may survive one or two episodes, but the eventual outcome is usually fatal hemorrhage—unless surgical excision or obliteration of the aneurysm is done. Therefore, arteriography should be carried out in patients who have survived a spontaneous subarachnoid hemorrhage, or in those who have had bouts of unilateral frontal pain associated with signs of involvement of the extra-ocular muscles, but without evidence of meningeal irritation.²¹

SUMMARY

1. The hypophysial fossas of young adult soldier patients have been measured in order to establish a standard. The average size was found to be anteroposterior 10.66 and depth 8.30 mm. with the following range:

Largest fossa—anteroposterior 13 × depth 9 mm.
Smallest fossa—anteroposterior 8 × depth 5 mm.

By comparison the average measurement of the fossas of six pituitary adenomas was anteroposterior 23 and depth 17 mm.

2. The normal variants observed have been considered and illustrated by line drawings for the purpose of clarity. One of these, the sinus of Berschet, is sometimes erroneously reported as the middle meningeal arterial channel. Another, the basilar sinus described by Batson and Kornblum, deserves wider recognition.

3. The ophthalmological considerations have been presented. *Choked discs are rarely seen with pituitary adenoma*, the important finding being a primary optic atrophy. Field changes may be simple or bizarre, depending on whether the area affected is the optic nerve, the optic tract, or whether the chiasm is involved alone or in combination.

4. Pathological changes in the pituitary fossa and its neighborhood have been briefly discussed and correlated with significant clinical findings.

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REFERENCES

1. BAILEY, O. T., and CUTLER, E. C. Malignant adenomas of chromophobe cells of pituitary cells body. *Arch. Path.*, 1940, 29, 368-399.
2. BAILEY, P. Intracranial Tumors. Charles C Thomas, Springfield, Ill., 1933, p. 2.
3. BATSON, O. V. Personal communication (teaching notes).
4. BELL, J. C. Apparatus for pneumo-encephalography. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1939, 42, 307-313.
5. BELL, J. C., and HEUBLEIN, G. W. Diagnostic roentgenology in an army general hospital during present war. *Radiology*, 1944, 43, 425-485.
6. CAMP, J. D. II. Normal and pathological anatomy of sella turcica as revealed by roentgenograms. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1924, 12, 143-156.
7. CAMP, J. D. Roentgenologic manifestation of intracranial disease. *Radiology*, 1929, 13, 484-493.
8. CUSHING, H. The Pituitary Body and Its Disorders, Clinical States Produced by Disorders of the Hypophysis Cerebri. J. B. Lippincott Co., Philadelphia, 1912.
9. CUSICK, P. L. Personal communication.
10. CUTLER, M., and BUSCHKE, F. Cancer. W. B. Saunders Co., Philadelphia, 1939, pp. 609-612.
11. DYKE, C. G., and DAVIDOFF, L. M. Roentgen Treatment of Diseases of the Nervous System. Lea & Febiger, Philadelphia, 1942, pp. 121-153.
12. DYKE, C. G. In: Diagnostic Roentgenology. Ross Golden, Editor. Thomas Nelson & Son, New York, pp. 34 D, E, F, G, H.
13. HEUBLEIN, A. C. Preliminary report on continuous irradiation of entire body. *Radiology*, 1932, 18, 1051-1062.
14. HEUBLEIN, G. W. Roentgenographic study of the infant skull. Unpublished thesis. Yale School of Medicine, 1934.
15. HEUBLEIN, G. W., PENDERGRASS, E. P., and WIDMANN, B. P. Roentgenographic findings in neurocutaneous syndromes. *Radiology*, 1940, 35, 701-727.
16. HODES, P. J. Personal communication (teaching notes).
17. HOLT, J. F., and HODGES, F. J. Significant skeletal irregularities of the hands. *Radiology*, 1945, 44, 23-31.

18. JEFFERSON, G. Extrasellar extensions of pituitary adenomas. *Proc. Roy. Soc. Med.*, 1940, 53, 433-458.
19. KORNBLUM, K. Alterations in structure of sella turcica as revealed by roentgen ray. *Arch. Neurol. & Psychiat.*, 1932, 27, 305-320.
20. LILLIE, W. I. Study of pathologic changes in optic nerves and chiasm in comparison with changes in visual field in association with large pituitary tumors. *Tr. Am. Ophth. Soc.*, 1931, 29, 433-444.
21. MAYFIELD, F. H. Personal communication.
22. MOOLTEN, S. E. Hamartial nature of tuberous sclerosis complex and its bearing on tumor problem. *Arch. Int. Med.*, 1942, 69, 589-623.
23. NEW, G. B., and STEVENSON, W. End results of treatment of malignant lesions of nasopharynx. *Arch. Otolaryng.*, 1943, 38, 205-209.
24. PANCOAST, H. K. Interpretation of roentgenograms of pituitary tumors. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1932, 27, 697-716.
25. PANCOAST, H. K. Röntgen diagnostic significance of erosion of optic canals in study of intracranial tumors. *Ann. Surg.*, 1935, 101, 246-255.
26. PANCOAST, H. K., PENDERGRASS, E. P., and SCHAEFFER, J. P. The Head and Neck in Roentgen Diagnosis. Charles C Thomas, Springfield, Ill., 1940, pp. 591-593.
27. PFAHLER, G. E., and PITFIELD, R. L. Calcification of pituitary with hypopituitarism and with symptomatic treatment. *Am. J. M. Sc.*, 1922, 163, 491-507.
28. PFAHLER, G. E., and SPACKMAN, E. W. Roentgen therapy in pituitary tumors. *Am. J. Ophth.*, 1931, 14, 796-807.
29. POHLE, E. A., Editor. Clinical Roentgen Therapy. Lea & Febiger, Philadelphia, 1938. Section by H. Langer, pp. 662-673.
30. SCHÜLLER, A. Roentgen Diagnosis of Diseases of the Head. Translation by F. F. Stocking. C. V. Mosby Co., St. Louis, 1918.
31. DE SCHWEINITZ, G. E. Concerning certain ocular aspects of pituitary body disorders, mainly exclusive of the usual central and peripheral hemianopic field defects. *Tr. Ophth. Soc. U. Kingdom*, 1923, 43, 12-109.
32. TRAQUAIR, H. M. An Introduction to Clinical Perimetry. Fourth edition. C. V. Mosby Co., St. Louis, 1943.
33. WALKER, C. B., and CUSHING, H. Chiasmal lesions, with especial reference to homonymous hemianopsia with hypophyseal tumor. *Arch. Ophth.*, 1918, 47, 119-145.



THE ROENTGENOGRAPHIC APPEARANCE OF THE FALX CEREBRI

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SHADOWS due to the deposition of calcium in relation to the falx are frequently observed in roentgenograms of the skull. The shadow of the normal falx cerebri appears to have escaped recognition, although it is always visible in adequate anteroposterior or posteroanterior roentgenograms.

The falx is seen as a narrow thread-like shadow in the midline of the skull (Fig. 1).



FIG. 1. The normal falx cerebri as seen in a posteroanterior roentgenogram.

It extends above to within a centimeter of the vertex (where the dura splits to enclose the longitudinal sinus), and below, it disappears a variable distance above the crista galli or merges into the shadow of the bony ridge of attachment of the falx. In occipitofrontal roentgenograms the shadow may be seen extending throughout the cranial

space above the shadow of the base. The shadow is of equal width in anteroposterior and posteroanterior roentgenograms. It corresponds in appearance and width with the shadow seen in encephalograms when gas occupies the subarachnoid spaces over the medial surfaces of the hemispheres. The shadow may sometimes be seen to deviate from the mid-plane of the skull, due to displacement caused by a space-occupying lesion. Pathological calcification plays no part in the production of the shadow, for it is seen in young children. When calcified plaques are present these lie alongside the falx rather than in it. In these cases the shadow of the remainder of the falx is no denser than usual.

It is believed that the shadow is due to the resistance opposed to the passage of roentgen rays by the dense fibrous tissue membrane. Figure 2 demonstrates that the normal falx is capable of absorbing rays sufficiently to cause a shadow. The dura mater of the vertex, including the falx, is removed and supported so that the falx is tightly stretched. A roentgenogram is taken. In Figure 2 the roentgen rays pass at right angles to the usual anteroposterior direction, and consequently through a much smaller depth of fibrous tissue. In spite of this, the shadow of the falx is as dense as that of the metacarpal bones. The following experiment shows that the falx is more resistant to the passage of roentgen rays than the normal brain. The falx is stretched horizontally behind a normal erect head in the anteroposterior position. A roentgenogram is taken with the tube at a distance of 6 feet. The shadow of the falx can be clearly seen.

The falx does not cast a shadow in lateral views because the depth of the tissue opposing the rays is only a very small fraction of that opposing the passage in roentgeno-

grams taken at right angles. The shadow is not seen in anteroposterior or postero-anterior roentgenograms in which the head is slightly rotated, nor when the tube has been shifted to one side for stereoscopic views. The absorption lessens as the plane of the falx deviates from the plane of the rays, for the rays pass through a smaller depth of tissue (Fig. 3). Also, the greater the rotation of the falx, the larger will be the area of projection upon the film, and consequently the more diffuse will be the shadow (Fig. 3).

The roentgenograms of 100 patients were examined to determine the frequency with

which the shadow could be seen. In each, two or three roentgenograms had been taken either in a posteroanterior or anteroposterior direction. In 65 the falx could be clearly seen in one or more views. The greater the number of roentgenograms taken, the more likely is the falx to be seen

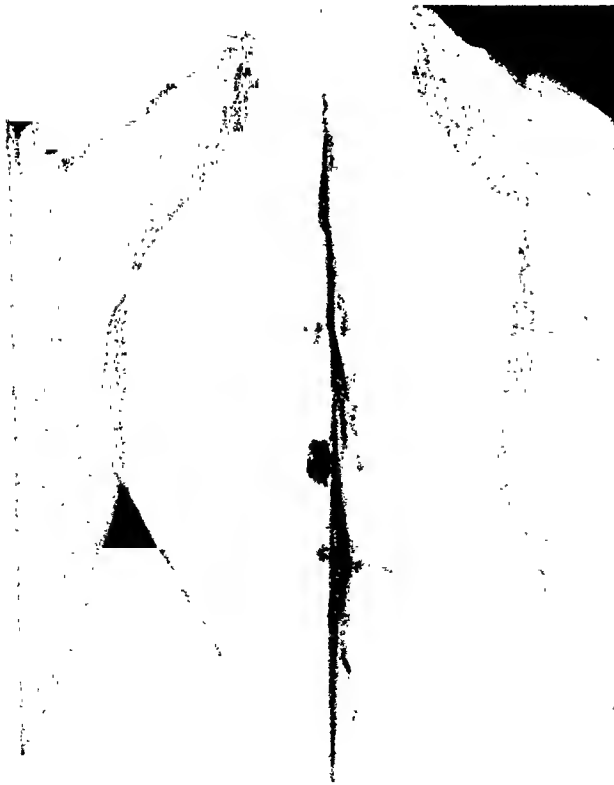


FIG. 2. Roentgenogram of the stretched falx cerebri. (The shadows of uniform density alongside the falx are due to supporting canes.)

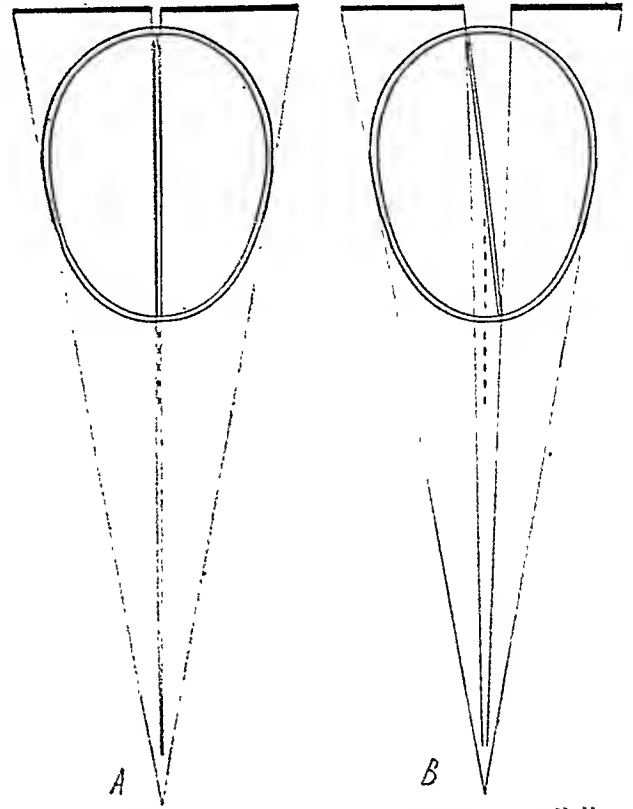


FIG. 3. Demonstrating the effect of imparallelism of the central ray and the falx. In (A) the rays are coplanar with the falx, and pass through the length of the falx. In (B) the rays pass only a short distance through the falx.

in one of them. In 28 patients short shadows could be seen, sufficient, however, to determine position and direction of the falx. In 9 cases the falx was not seen. Examination of the roentgenograms in which the shadow was not seen suggested that slight rotation of the skull was the commonest cause of failure. Unusual density of the cranial bones, or a pronounced diploic pattern, may be sufficient to conceal the shadow of the falx.

The shadow has considerable practical importance. Since the falx separates the two cerebral hemispheres it is a true indication of the position of the great longi-

tudinal fissure. This does not always coincide with the apparent midline of the skull drawn from bony landmarks. If the groove of the sagittal sinus is visible, the line of the falx will sometimes meet it to one side of the mid-point of the depression. The sinus itself is seen if calcium salts have been deposited along its dural walls, and occasionally, if a sufficient length of the sinus



FIG. 4. Displacement of the falx produced by a left-sided parietotemporal cystic astrocytoma.

is along the plane of the rays, the divergent layers of the dura may be seen in the absence of calcification. The walls of the sinus and the falx do not always form a symmetrical Y.

The difficulty of determining the mid-plane of the skull and its occasional divergence from the cerebral midline leads to difficulty in recognizing small lateral displacements of the calcified pineal gland. If the pineal gland is in the line of a vertical undeviating falx, displacement is unlikely. In normal cases the line of the falx is a truer indication of the mid-plane than that drawn from bony landmarks. These points are dealt with more fully in "Further Contributions to Encephalography."*

However, the falx is not a rigid immobile

structure. Hence, it is not an infallible index of the position of the mid-plane of the skull. The fibrous partition is sufficiently strong to oppose a considerable displacing force, while the cerebral tissues tend to herniate beneath the incisura tentorii away from the side of higher pressure. Hence the pineal gland may be displaced, while the falx remains in the mid-plane. As the displacing force increases, the falx also becomes displaced. Because the falx is displaceable, it may provide important evidence of the presence of a space-occupying lesion in patients in whom the pineal gland and choroid plexuses are not calcified. In several patients it has been of very great value. In 2 it served to provide evidence of the presence and position of subdural and extradural hemorrhages, and in another to provide conclusive evidence of the presence of a neoplasm, at a time when there was no definite evidence of increased intracranial pressure (Fig. 4).

The falx is visible in a smaller percentage of patients with cerebral tumors than in normal individuals. This is due to the fact that displacement tends to carry the falx out of the plane of the rays. No shadow will be visible unless a sufficient length of falx is situated along the plane of the rays. A tumor may cause the falx to bow to such a degree that the absorption of the rays is too slight and diffuse to be manifest. In some roentgenograms the falx was seen in the midline, in others a slant proved the presence and lateralization of an expanding lesion. The edges of the shadow were usually less sharp than when there was no displacement. In a few cases a double shadow could be seen. This appearance must be due to an accident of displacement, two areas being along the direction of the rays. In a consecutive series of 50 cases of proved neoplasms the falx was seen in 28 cases. In 15 it was central, in 13 displaced, and in the remaining 22 it was not seen. It is probable that the displacement of the falx explained the absence of the shadow in most of these cases.

* A monograph by the author to be published shortly.

It has not been possible to recognize a shadow corresponding to the tentorium, in spite of the taking of special roentgenograms. The tentorium is a curving partition and it is probable that there is insufficient membrane coplanar with the rays to cause appreciable absorption.

SUMMARY

The falx cerebri can be seen in a large percentage of properly taken roentgenograms of the skull.

The shadow is due to absorption of roentgen rays coplanar with the falx.

Imparallelism of the falx and the rays interferes with visualization.

In normal cases the shadow represents the true cerebral midline.

Displacement of the shadow is sufficiently frequent to make its recognition a valuable clinical sign.

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PRIMARY ATYPICAL PNEUMONIA

A DISEASE OF SEGMENTAL DISTRIBUTION*

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AN ANALYSIS of the roentgenographic manifestations of atypical pneumonia has been reported previously.³ This further study is presented because it confirms the conclusions of the earlier contribution and, in addition, has clarified the anatomic characteristics of the disease which distinguish it from the lobar and lobular variants.

The previous paper, in accordance with the observations of others,^{2,4,8} emphasized that (*a*) the process is usually basal, but the upper fields are not immune; (*b*) in the established case, as a rule, the roentgen opacity is homogeneous and translucent; (*c*) early characteristics are blurring of the structural markings fanwise from the hilum, and (*d*) resolution is almost a complete reversal, intensification of the bronchovascular markings being the last sign of previous parenchymal infiltration to disappear. Minimal atelectatic manifestations were observed with a frequency of 20 per cent; bronchiectasis was demonstrated in approximately 2 per cent of all cases.

Experience with the roentgen examination of the chest in approximately 1,000 cases of definite or clinically suspected atypical pneumonia permits the further generalization that this is essentially a pneumonia of segmental distribution. Illustrative cases will be cited to demonstrate this previously unreported fundamental fact.

THE BRONCHOPULMONARY SEGMENTS

The roentgen localization of intrathoracic disease requires familiarity with the distribution of the bronchial ramifications. Peirce and Stocking⁹ have clearly demonstrated the right and left oblique projec-

tions of the thorax to be most advantageous for full visualization of the bronchial tree, the secondary ramifications of which were named by these authors as follows:

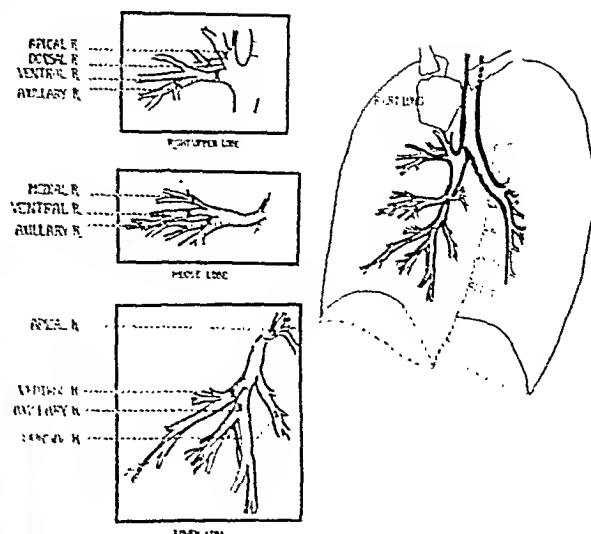
RIGHT (Left anterior oblique projection—Fig. 1)	LEFT (Right anterior oblique projection—Fig. 2)
<i>Upper Lobe</i>	<i>Upper Lobe</i>
a. Ventral	a. Ventral
b. Apical	b. Apical
c. Dorsal	c. Dorsal
	d. Lingular
<i>Middle Lobe</i>	
a. Medial	
b. Ventral	
c. Axillary	
<i>Lower Lobe</i>	<i>Lower Lobe</i>
a. Apical	a. Apical
b. Dorsobasilar	b. Dorsobasilar
c. Axillary-basilar	c. Axillary-basilar
d. Ventrobasilar	d. Ventrobasilar

The above nomenclature is considered the most precise and practical of that in common use. It has been employed exclusively in this study and its validity is confirmed.

While oblique studies of the chest after lipiodol instillation most advantageously demonstrate the bronchial tree, the *frontal* view with appropriate *lateral* projections has been found best suited for routine localization, particularly the translucent parenchymal infiltrations of bronchogenic origin. The lateral roentgenogram also affords unrestricted visualization of the pulmonary fields behind the heart and below the summit of the diaphragm—areas which are obscured in the frontal view. Orientation is aided by knowledge of the location of the pulmonary fissures as seen in the lateral projection, the details of which

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B

FIG. 1. (A) Left anterior oblique projection of chest demonstrates normal right bronchial tree.

(B) Diagrammatic representation of structures shown in (A).



B

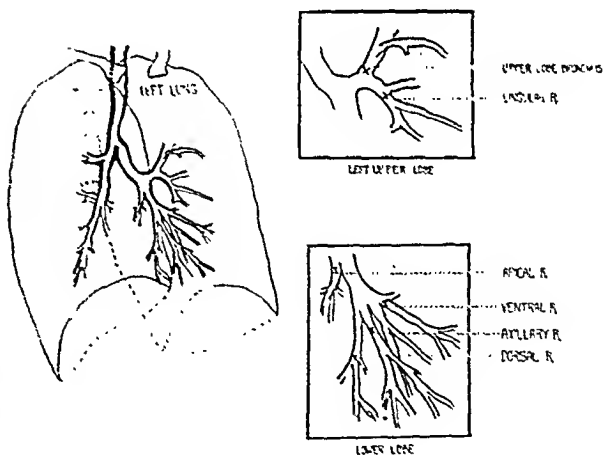


FIG. 2. (A) Right anterior oblique projection of chest shows normal left bronchial tree of same patient as in Figure 1. (B) Diagrammatic representation of structure shown in Figure 2 A.

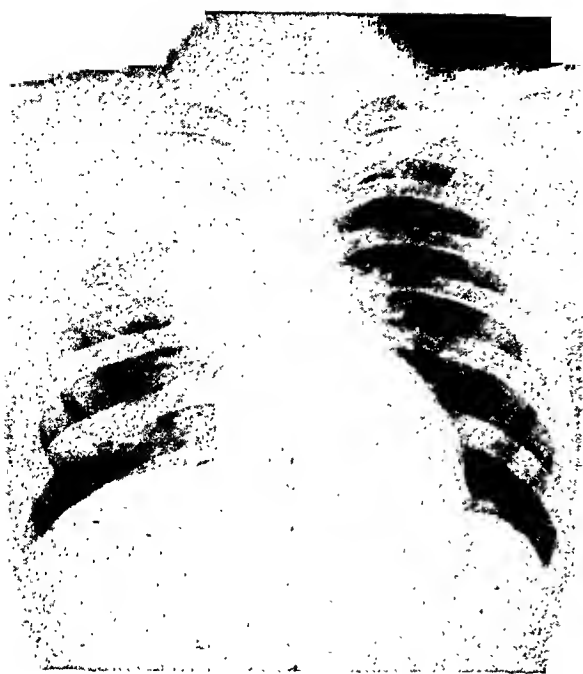


FIG. 3. Ventral segment of right upper lobe.

among others have been investigated by Levitin and Brunn,⁵ Berry and Childs,¹ and Medlar *et al.*⁷ The parentage of the bronchovascular markings should be kept in mind when the frontal study is inspected, as well as the projected periphery of the pulmonary fissures.

BRONCHOPULMONARY LESIONS

Atypical pneumonia occurs most frequently in the lower lobes where 80 per cent of the infiltrations are seen. The dorso-basilar is the most common segment to be involved.

It is to be noted that all bronchopulmonary segments supplied by the secondary bronchi are pyramidal with the apex directed toward the hilum where the secondary bronchi arise, the base facing a pleural surface. The length of the pyramid and the diameter of its base will vary with the particular segment concerned. Hence, the ventral segments of the upper lobes are of short stature and have a broad base, whereas the basilar segments of the lower lobes are long and tapering.

While the large majority of established infiltrations are confined to the bronchopulmonary segments supplied by a secondary bronchus, small lesions are occasionally

seen involving only the cone supplied by a tertiary bronchus; the ventral segments of the upper lobes are excellent examples. The ventral ramus of each upper lobe bronchus divides into two principal branches which diverge at nearly a right angle—a ventral tertiary ramus and an axillary tertiary ramus. It is not uncommon to see either of these tertiary segments involved separately, or one involved in greater degree than the other.

The following illustrative cases have been selected from the series to demonstrate the segmental character of atypical pneumonia, and to further elucidate the bronchopulmonary anatomy.

Right Lung

Upper Lobe

(a) Ventral Segment (Fig. 3). When completely infiltrated this segment is seen in the right upper lung field, projected between the anterior arcs of the first to fourth ribs, limited inferiorly by the horizontal fissure and extended from mediastinum to axilla. The outline is roughly pyramidal in frontal projection with the ventral component viewed axially overlying the upper part of the hilum. The lateral view shows the pyramidal ventral tertiary segment running anteriorly from the upper extremity of the hilum and the axillary

component is seen end on, directed laterally from the same level and hence circular.

(b) *Apical Segment* (Fig. 4). This is infrequently involved but when seen the pyramid is viewed throughout its length in the frontal projection and is seen passing superiorly from the upper aspect of the hilum to the extreme apex. The lateral projection reveals the lesion passing upward somewhat obscured at the apex by the superimposed pectoral girdles.

(c) *Dorsal Segment*. No case of atypical pneumonia has been localized in this segment. This is perhaps significant, for all other secondary segments of the lungs have been demonstrated by infiltrative changes due to atypical pneumonia. Attention is called to the fact that the dorsal segment of the upper lobes is a common site of tuberculous infiltration.

Middle Lobe. Although in general all segments of the middle lobe can be fully surveyed in the frontal projection, the lateral view will serve to delineate the extent of the process in this lobe.

(a) *Medial Segment* (Fig. 5). This region extends inferiorly from the lower aspect of the hilum against the mediastinal surface to occupy the right cardiohepatic angle. In frontal view this pyramid is foreshortened since it is obliquely projected. The lateral view discloses the segment limited posteriorly by the lower extremity of the main fissure, anteriorly by the anterior surface and inferiorly by the diaphragmatic surface of the middle lobe. The ventral segment lies laterally.

(b) *Ventral Segment* (Fig. 6). In frontal

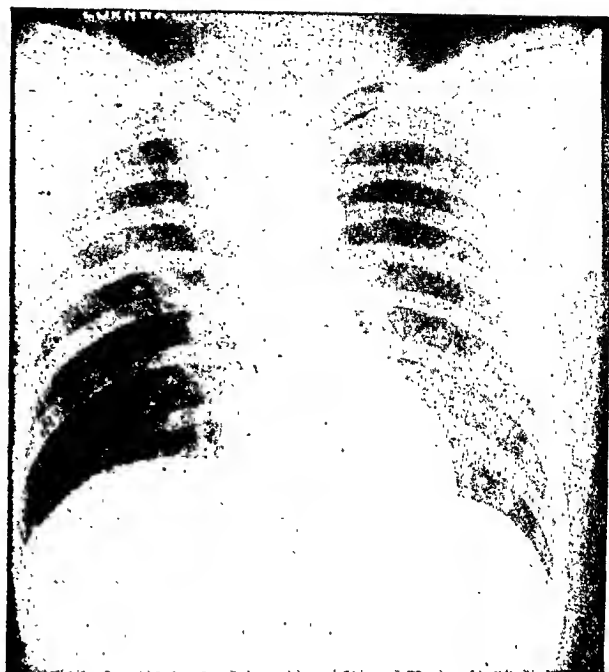


FIG. 4. Apical segment of right upper lobe.

projection this segment is also foreshortened since it likewise extends downward and forward from the lower end of the hilum, between the medial and axillary segments. It stops abruptly at the level of the anterior arc of the fifth rib and interspace, being the inferior limit of the middle lobe at this sector. In lateral projection the area is limited superiorly by the axillary segment, posteriorly by the lower end of the main fissure and anteriorly by the anterior surface of the middle lobe.

(c) *Axillary Segment* (Fig. 7). As named, this

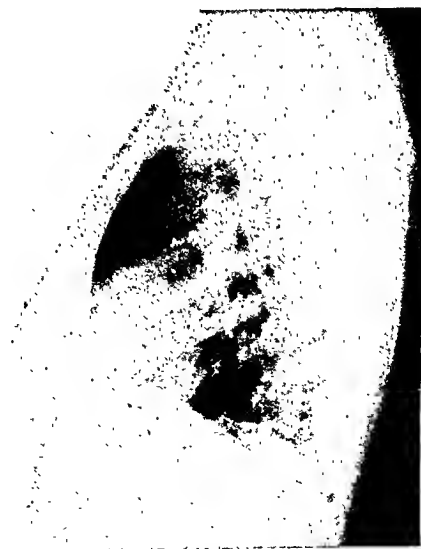


FIG. 5. Medial segment of right middle lobe.

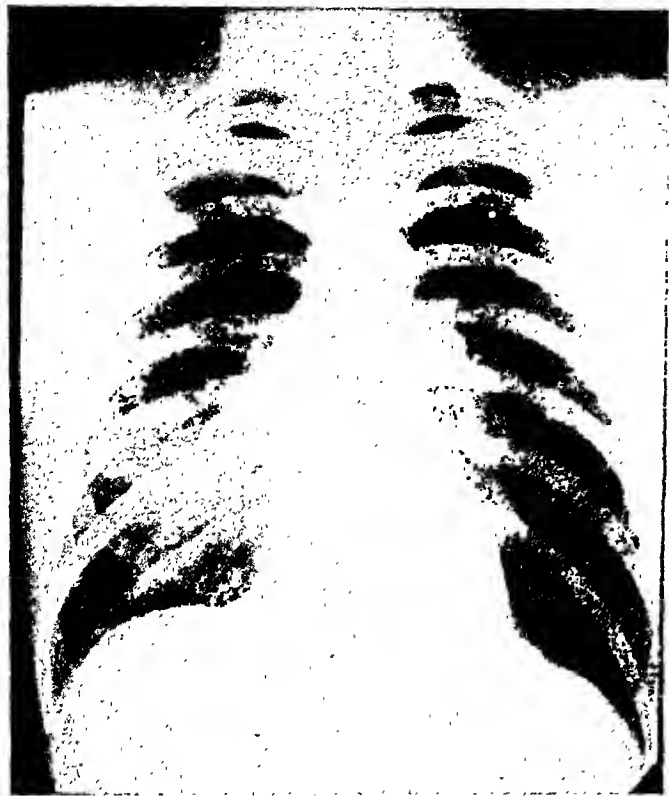


FIG. 6. Ventral segment of right middle lobe.

segment extends directly laterally from the hilum and in frontal view is projected in complete profile, apex directed toward the hilum and the base extending to the inferolateral surface of the middle lobe. The segment is sharply defined superiorly by the minor fissure, and lies adjacent to the ventral segment inferiorly.

The lateral projection reveals the posterior limit to be that portion of the main fissure just below the hilum and above the dome of the diaphragm.

Lower Lobe

(a) Apical Segment (Fig. 8). Embryologically, this segment develops as a separate unit and is said to occasionally possess a fissure which limits it from the remainder of the lower lobe. This segment is a frequent site of lung abscess, a fact which is made apparent when it is recalled that the right apical bronchus is easily entered by infected secretions or small foreign bodies when the patient is either supine or standing.

In frontal view the segment when involved by infiltration is seen axially, hence circular in contour, projected between the eighth and ninth costovertebral junctions and extending from mediastinum to axillary one-third of the lung field. The upper and outer boundary of the segment is defined by the apex of the lower lobe, which it will be recalled passes in an arc laterally and inferiorly, thereby limiting the process to the medial two-thirds of the lung field. Since this segment overlies and frequently obliterates the hilum, it is probable that infiltrations of this segment have been incorrectly termed "hilar pneumonia." Lateral projection reveals the true state of affairs where the apical segment is seen as a squat pyramid extending



FIG. 7. Axillary segment of right middle lobe.



FIG. 8. Apical segment of right lower lobe.

directly posteriorly from the hilum with its base facing the posterior surface of the lung. Inferiorly the segment lies adjacent to the basilar divisions.

(b) Dorsobasilar Segment (Fig. 9). This is the commonest site of atypical pneumonia. It is commonly obscured by the summit of the diaphragm and the cardiac shadow, particularly on the left side. The segment extends inferoposteriorly with its apex at the lower hilar extremity. In frontal view, the segment occupies the posteromedial portion of the lower lobe, projected at the cardiohepatic angle in a

manner similar to that of the medial segment of the middle lobe. The lateral projection clearly localizes the segment extending downward and back to the posterior costophrenic angle, well below the summit of the diaphragm.

(c) Axillary-Basilar Segment (Fig. 10). This area is clearly identified in the frontal projection where it is seen as a pyramid extending inferiorly and laterally from the hilum, with the apex directed centrally and the base occupying the lateral costophrenic angle. This accurately places the segment in the lower lobe as the inferolateral extremity of the middle lobe falls

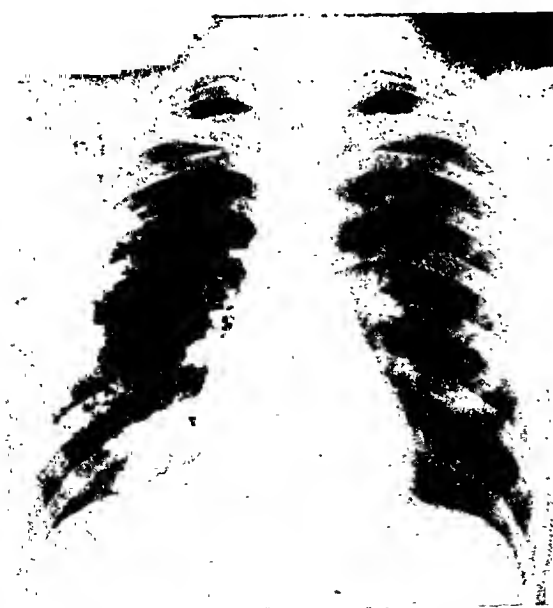


FIG. 9. Dorsobasilar segment of right lower lobe.



FIG. 10. Axillary-basilar segment of right lower lobe.

considerably short of the lateral costophrenic angle. The lateral projection reveals the process to lie posteriorly but in a plane just anterior to that of the dorsobasilar segment.

(d) Ventrobasilar Segment (Fig. 11). In frontal view, this unit is projected in a position midway between the dorsal- and axillary-basilar segments. Seen in the lateral roentgenogram, the ventrobasilar segment lies almost in a vertical plane extending inferiorly and slightly forward from the hilum to the summit of the

diaphragm: thus it is ventral to the dorsobasilar and axillary-basilar components with its anterior boundary furnished by the inferior extremity of the main fissure.

Left Lung (Fig. 12-19)

The segmental distribution of the left lung is in large part similar to the right, the outstanding anatomical difference being the lingular segment which is homologous to the right middle lobe.

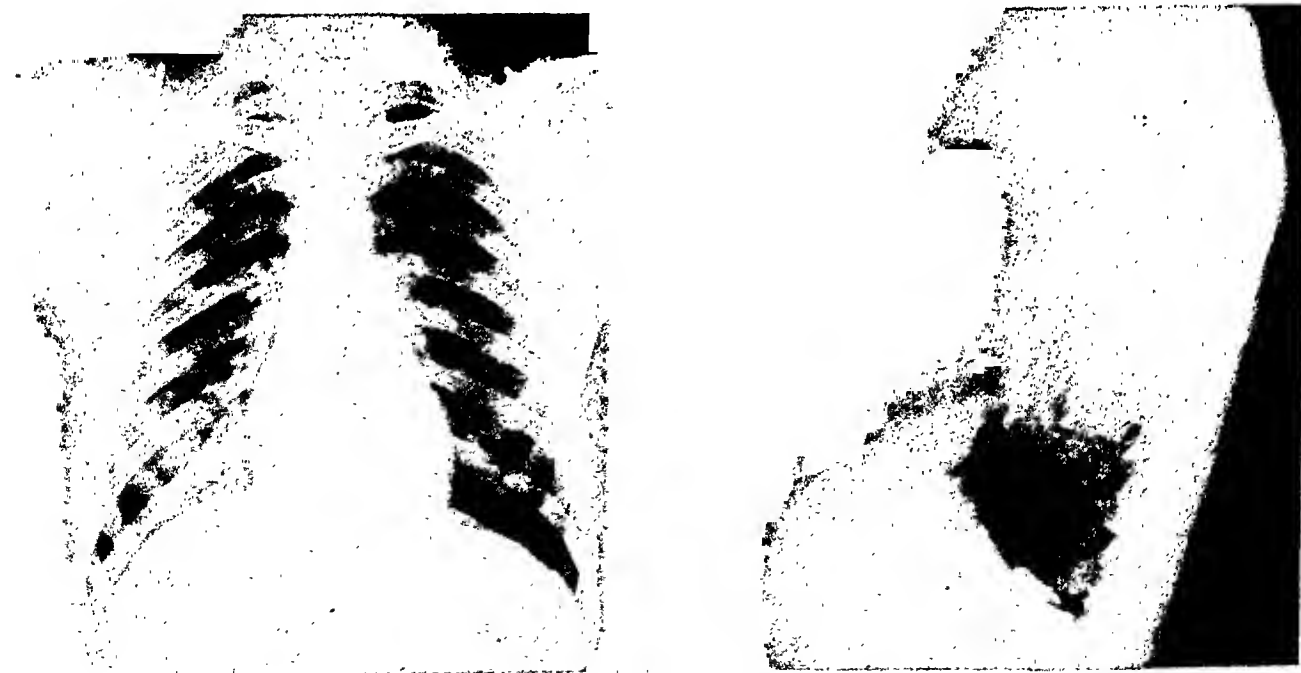


FIG. 11. Ventrobasilar segment of right lower lobe.

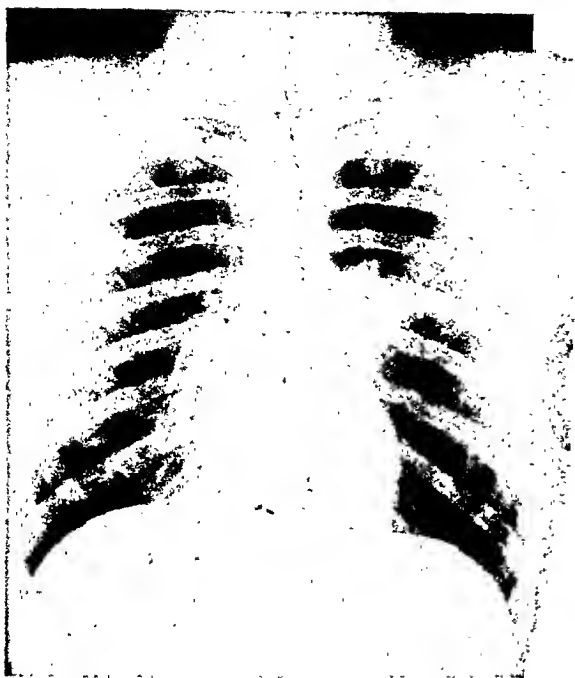


FIG. 12. Ventral (tertiary) segment of left upper lobe.

Lingular Segment (Fig. 14). The bronchus supplying this segment arises from the left upper bronchial trunk and supplies the infero-lateral third to half of that lobe. The segment extends to the diaphragmatic surface medially, arching laterally and upwards in much the same manner as the right middle lobe. The lingular bronchus ramifies into median and

axillary divisions, the first supplying the lung parenchyma adjacent to the left cardiac border, the second extending to the lower axillary lung field, but never to the costophrenic angle. It follows that an infiltration confined to this segment occupies the medial and basal lung field beside the cardiac border and extends laterally toward the axillary zone, upward to

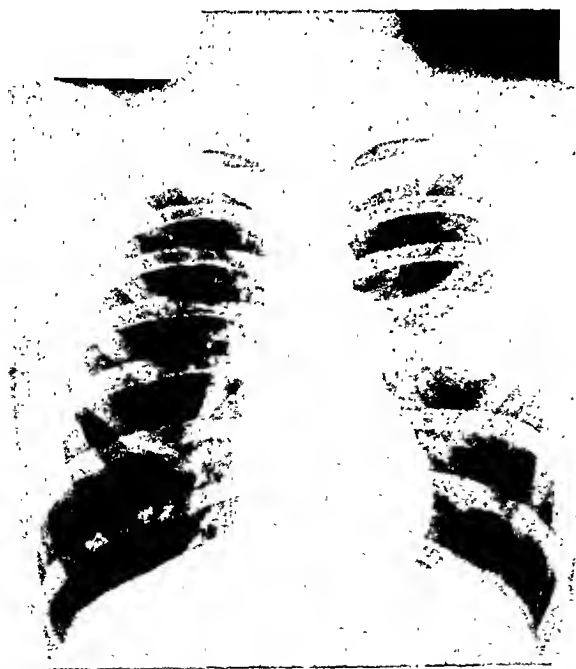


FIG. 13. Axillary (tertiary) segment of left upper lobe. The ventral and axillary tertiary segments of the upper lobes constitute the ventral secondary segment—see text.

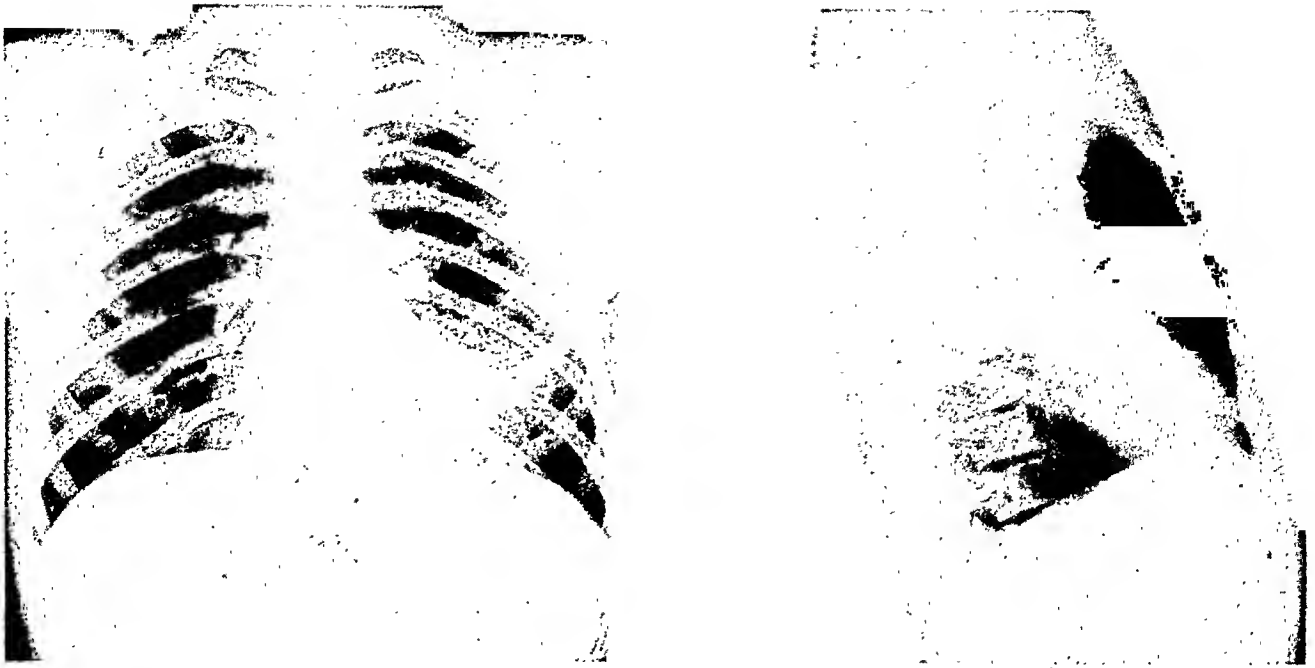


FIG. 14. Lingular segment of left upper lobe. Note the smaller diaphragmatic surface of this segment in comparison to that of the right middle lobe.

the third intercostal space. The median component occupies the left cardiohepatic angle in much the same manner as the medial segment of the middle lobe occupies the same angle on the right. In lateral projection the tongue-like shadow extends downward and forward from the hilum. The posterior boundary is the lower part of the main fissure; anteriorly is the pleural surface and above lies the ventral segment. Resolution of atypical pneumonia in this segment is frequently delayed. In bronchography,

careful attention should be given to the lingula for it has been observed to be rather frequently involved in bronchiectasis either alone or along with the basilar rami.

Left Dorsobasilar Segment (Fig. 17). This segment, while posterior, is also projected in the cardiohepatic angle but never extends as far laterally as the lingula. Frequently it is hidden by the cardiac apex. The lateral projection provides an unrestricted visualization of the segment and has not infrequently been



FIG. 15. Apical segment of left lower lobe.

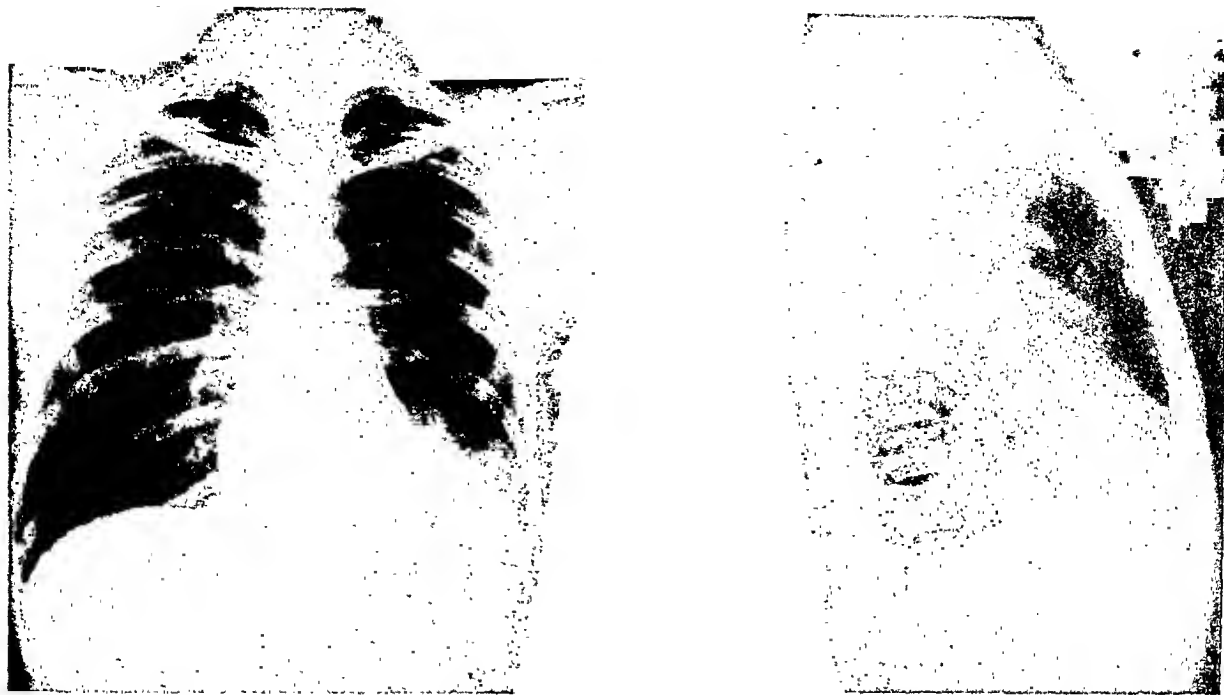


FIG. 16. All basilar segments of left lower lobe. Note that the lower end of the main fissure is displaced posteriorly due to accompanying atelectasis.

the sole clue to the correct diagnosis. This perhaps explains the discrepancy occasionally described between the clinical and roentgen findings when the lateral study has been omitted.

The Apical Segments of the Lower Lobes (Fig. 8 and 15). In this series the apical segment of the right lower lobe has occupied a consistently lower position than the left, the projected upper boundary on the right being

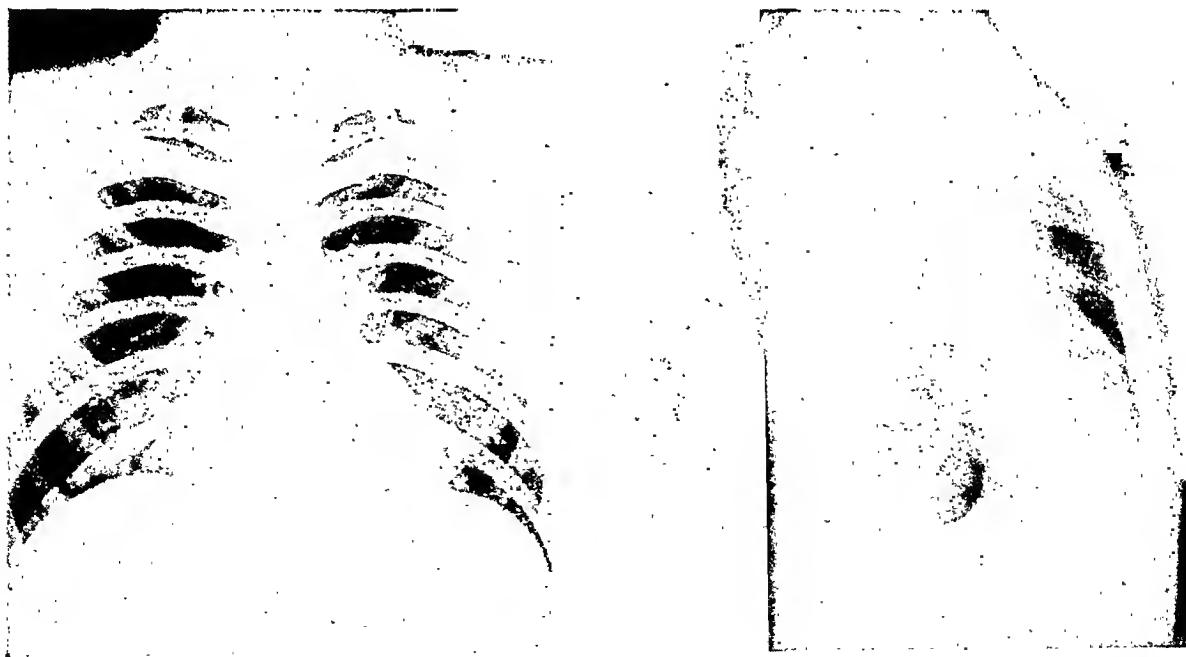


FIG. 17. Dorsobasilar segment of left lower lobe. The lateral study clearly reveals the infiltration to lie behind the heart and below the summit of the diaphragm. These areas are not seen in the frontal view which accounts for the absence of infiltrative changes in this projection.

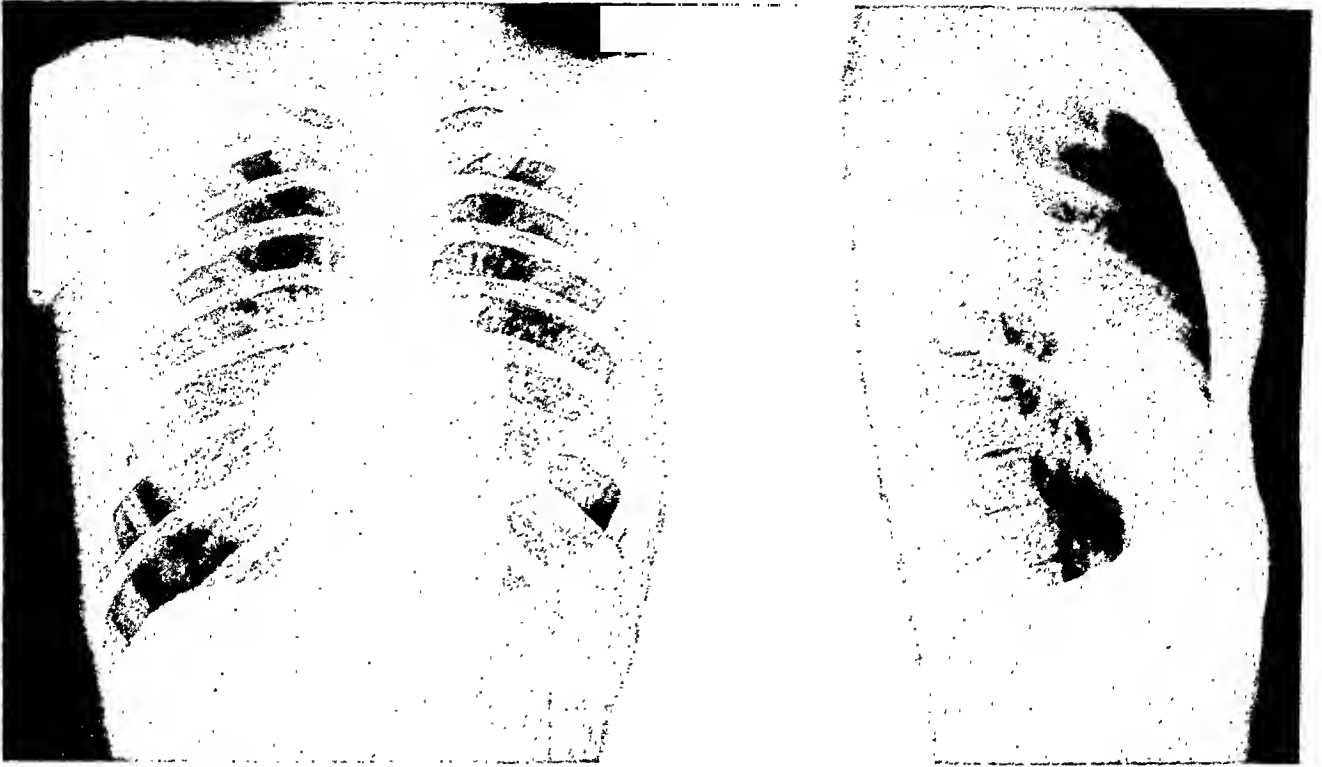


FIG. 18. Axillary-basilar segment of left lower lobe.

at the eighth posterior costovertebral junction in comparison with the sixth on the left. The combined volumes of the right upper and middle lobes is greater than that of the left upper lobe which probably accounts for the discrepancy.

DISCUSSION

It is generally agreed that "atypical"

pneumonia is manifested on roentgen examination as a peribronchial infiltration which usually coalesces as a homogeneous translucent opacity. This conception differs little from that of bacterial bronchopneumonia (lobular pneumonia) which commonly involves the parenchyma similarly but without strictly confining its

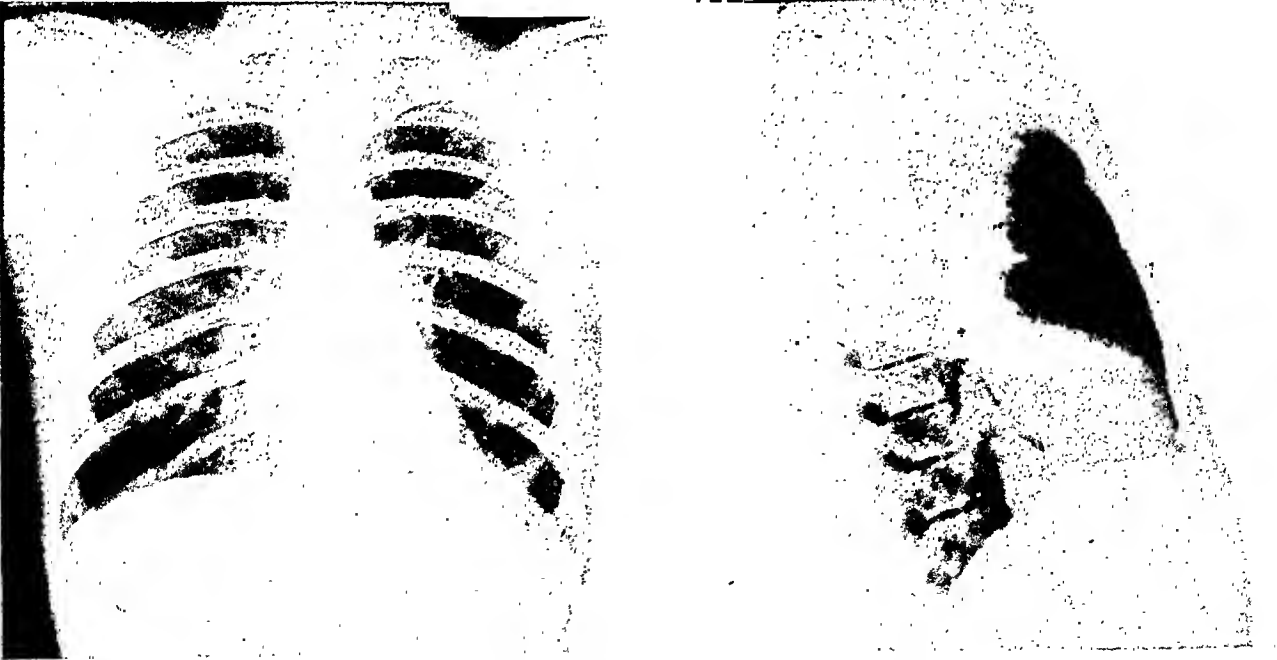


FIG. 19. Ventrobasilar segment of left lower lobe.

boundaries to either a single lobe or segment thereof. The present study has clearly demonstrated atypical pneumonia to differ sharply from lobar and lobular types by its bronchopulmonary segmental nature. This feature is unique; accordingly the disease should be considered a confluent lobular infiltration characterized by a marked segmental distribution.

It is significant that such infiltrations are most common in the basilar pulmonary areas, for in the series observed the upper lobes were involved infrequently, and in no case was the process identified in their dorsal segments. Evidence such as this suggests that the disease results from aspiration of the infective agent to cause a descending bronchogenic infection of the pulmonary parenchyma. This conception is further enhanced by the occurrence of minimal atelectatic phenomena which is probably responsible for the infrequent establishment of bronchiectasis.

That the dorsal segments of the upper lobes were not involved by atypical pneumonia is of some diagnostic significance for they are favorite sites of pulmonary tuberculosis. Recheck in ten days, however, is sound advice when the latter diagnosis is suspected.

The factor responsible for the discrepancy in the levels of the extreme apices of the lower lobes has been considered. In addition they have been observed to occupy a somewhat lower level (eighth costovertebral junction on the right, sixth on the left) than that generally reported (third and sixth costovertebral junctions). The latter determinations were obtained from autopsy material whereas this study has been performed on living subjects who were roentgenographed in the erect position during suspended deep inspiration. The upright position unquestionably elongates the thoracic viscera and probably lowers the apices of the inferior lobes from their position with the subject prone. Macklin's work⁶ supports the view of a lower position for the apices during inspiration. The lower

lobe bronchi have been demonstrated by him to lengthen in an inferolateral direction during inspiration which must necessarily cause similar displacement of the apical together with the adjacent segments relative to the fixed position of the costovertebral junctions. Finally, these observations have been confirmed in a case of atypical pneumonia involving the apical segment of the left lower lobe: Roentgenograms were taken with the patient prone during suspended expiration and in the conventional pose, while standing during suspended deep inspiration. In the former instance, the apex was at the third posterior interspace and in the latter at the sixth costovertebral junction.

While atypical pneumonia is of less significance in civilian than in military practice, similar bronchopulmonary lesions form a significant quota of intrathoracic disease, e.g., pulmonary tuberculosis, bronchial tumors, bronchial stenosis, bronchiectasis, bronchial foreign bodies. Thus, it is felt more thought should be placed on the segmental anatomy of the lung, particularly from the standpoint of localization, thereby rendering further assistance to the thoracic surgeon as well as to the internist. The physical signs elicited on clinical examination of the chest are of greater significance when considered in the light of segmental anatomy as shown in this series.

SUMMARY AND CONCLUSIONS

1. In the established case, the roentgen opacity produced by atypical pneumonia is homogeneous and translucent; early changes cause blurring of the bronchopulmonary markings; resolution is almost in reverse order, structural intensification being the last sign of previous parenchymal infiltration to disappear.

2. By routine use of the appropriate lateral projection of the chest in conjunction with the conventional frontal study, it has been abundantly demonstrated that the infiltration of atypical pneumonia is

segmental in type, the distribution being closely related to the zones supplied by the secondary rami of the bronchial tree. That the disease is one of bronchogenic origin is further attested by the frequent occurrence of minimal atelectasis and followed infrequently by secondary infection and development of bronchiectasis.

The intralobar septa probably serve as limiting boundaries to the characteristically preponderant interstitial reaction. The disease should therefore be considered anatomically as a confluent lobular pneumonia of segmental distribution in contradistinction to the lobar and lobular variants.

3. Consideration has been given to the position of the apex of the lower lobes.

4. The value of the lateral study of the thoracic viscera has been amply demonstrated in this series. Its use in routine study of pulmonary disease is strongly recommended.

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REFERENCES

1. BERRY, F. B., and CHILDS, E. P. Fissures of the lungs. *Ann. Surg.*, 1932, 96, 961-972.
2. CAMPBELL, T. A., STRONG, P. S., GRIER, G. S. III, and LUTZ, R. J. Primary atypical pneumonia. *J. Am. M. Ass.*, 1943, 122, 723-729.
3. CRYSLER, W. E. The roentgenographic manifestations of atypical pneumonia of unknown etiology. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1944, 51, 280-291.
4. HUFFORD, C. E., and APPLEBAUM, A. A. Atypical pneumonia of probable virus origin. *Radiology*, 1943, 40, 351-360.
5. LEVITIN, J., and BRUNN, H. Study of roentgenologic appearance of lobes of the lung and interlobar fissures. *Radiology*, 1935, 25, 651-680.
6. MACKLIN, C. C. The dynamic bronchial tree. *Am. Rev. Tuberc.*, 1932, 25, 393-417.
7. MEDLAR, E. M., PESQUERA, G. S., ORDWAY, W. H., and LASHER, E. C. The demonstration of pulmonary lobes and interlobar fissures by roentgenograms of an artificial thorax. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1944, 51, 267-279.
8. OWEN, C. A. Primary atypical pneumonia. *Arch. Int. Med.*, 1944, 73, 217-231.
9. PEIRCE, C. B., and STOCKING, B. W. Oblique projection of the thorax; anatomic and roentgenologic study. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1937, 38, 245-267.



ROENTGENOLOGIC STUDIES ON THE EFFECT OF SYNTHETIC FOLIC ACID ON THE GASTRO- INTESTINAL TRACT OF PATIENTS WITH TROPICAL SPRUE*†‡

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WE HAVE observed that a profound improvement occurs in the glossitis as well as in symptoms referable to the gastrointestinal tract of patients with nutritional anemia and pernicious anemia when treated with synthetic folic acid.¹ Early in our studies concerning the effect of folic acid on the anemia of tropical sprue we were impressed by the severity of the gastrointestinal complaints in these patients and we endeavored to determine what changes, if any, occurred in alimentary tract function when this substance was used as the only treatment. Although many patients with tropical sprue were studied from this point of view, the present report is limited to our observations on 2 patients with severe tropical sprue who were studied roentgenographically before, during, and after therapy with folic acid. As a means of comparison, a study on a normal control and on a positive control who received no specific therapy is also included in this report. Using the following criteria 3 patients with tropical sprue were selected for study:

1. The patient must have glossitis.
2. He must have diarrhea, characterized by voluminous, foul smelling, frothy, liquid, yellow stools.
3. The stools must have an increased fat content as determined by chemical analysis.

4. A body weight loss of at least 20 pounds must have occurred during the six months preceding the initiation of this study.

5. He must have a macrocytic hyperchromic anemia with a red blood cell count of 2.5 million or less and a color index of 1.0 or more.

6. There must be megaloblastic arrest of the sternal bone marrow.

7. There must be free HCl acid present in the gastric juice on fractional analysis after histamine stimulation.

8. The oral glucose tolerance curve must be flat.

9. The blood calcium level must not be below 8.5 mg. per 100 cc.

10. The serum amylase and lipase activity must be normal.

11. The patient must not have had specific therapy within the five weeks preceding the study.

Each patient thus selected was hospitalized and received a daily diet which contained no meat, meat products, fish or fowl, and which allowed one egg and one pint of sweet milk. Prior to the initiation of therapy baseline clinical, laboratory and hematological studies were done as previously described.² In addition to these studies, routine gastrointestinal roentgen series were performed. These series were repeated again during the course of therapy with folic acid and also after clinical and hematological recovery were complete.

The routine roentgen examination procedure was as follows. The patient was

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‡ The folic acid for the study was supplied by Lederle Laboratories, Inc.



FIG. 1. Case 1.

denied everything by mouth after 7 p.m. the night before the examination. At about 8:30 a.m. the day of the examination he was given the contrast medium which consisted of 100 gm. of chemically pure barium



FIG. 2. Case 1.

sulphate, suspended in 150 cc. of water. No other ingredients were added to this medium. Roentgenograms taken at fifteen minutes, forty-five minutes and one hour after the contrast medium had been ingested and each hour thereafter until the head of the barium column reached the cecum. Rigid adherence to this schedule was not feasible in some cases because of the great degree of intestinal hypomotility. In such instances it was necessary to select



FIG. 3. Case 1.

time intervals more suitable to each patient.

CASE 1 was a normal control who had no condition which might possibly have resulted in altered alimentary tract function nor was there a past history of such a condition. Using the procedure described above a complete gastrointestinal roentgen series was obtained as a means of comparison and in order to demonstrate the findings in a normal individual. Figures 1 and 2 show that the passage of barium through the central and distal portion of the jejunum is normally quite rapid. The jejunum is seen to be of generally greater diameter than the ileum and the mucosa of the jejunum is

normally well visualized, whereas that of the ileum is not. The two figures (Fig. 1 and 2) demonstrate the normal continuous, connected barium column in the small intestine; this column is never fragmented nor interrupted normally. After the barium has passed from one portion of the jejunum to another there may be seen many very fine, small, almost invisible deposits of contrast medium among the recesses between the folds of the jejunum in some cases.



FIG. 4. Case II.

This trace of barium is normal. The head of the barium column usually enters the cecum within two hours after ingestion, as shown in Figure 3. This is considered the normal time interval for this passage in residents of Cuba and by this means we measured intestinal motility.

CASE II (F. P.) fulfilled our criteria for tropical sprue and was used as a positive control. He received no specific therapy during this study. The first gastrointestinal roentgen series was done on January 28, 1946. Figure 4 represents the thirty minute roentgenogram and shows the stomach and duodenal cap almost free of barium. A "stack of coins" and "wheel" effect, both of which in reality are the result of mucosal edema, can be seen in the proximal portion of the jejunum. Alternating intestinal spasm and



FIG. 5. Case II.

dilatation is clearly seen in Figure 5. At the end of one hour there was a striking distribution of the barium into numerous, irregularly shaped



FIG. 6. Case II.



FIG. 7. Case III.

clumps of barium, an appearance which warrants the descriptive term "moulage" or "clumping" of barium. These findings are



FIG. 8. Case III.

shown in Figure 6. The general conclusions in this first series of roentgenograms were intestinal hypomotility, mucosal edema, and alternating areas of intestinal dilatation and spasm. A second series of roentgenograms were taken on February 16, 1946, and there was essentially no change. The third and last series was done on March 9, 1946, and there was no change except for very slight improvement in intestinal motility. Segmentation and fragmentation of the barium column was as severe at the time of this examination as it was in the initial series.



FIG. 9. Case III.

CASE III (E. V.) had severe tropical sprue. He was roentgenographed on February 7, 1946, prior to receiving any specific therapy. The intestinal mucosa was edematous and irregular. There were numerous, isolated, dilated segments of jejunum filled with barium which were connected by thin bands of spastic jejunum, and the barium showed a severe degree of puddling (Fig. 7). There was a great degree of intestinal hypomotility, the head of the barium column still not having reached the cecum at the end of two hours (Fig. 8). These studies were repeated on March 9, 1946, after thirty-four days of treatment with 10 mg. of folic acid by mouth. There was striking improvement as evidenced by more normal con-

tinuity of the column of barium, less mucosal edema and much less segmentation (Fig. 9). The head of the column of barium had reached the cecum in less than four hours, showing improvement in intestinal motility. The third roentgen series was done on April 13, 1946, after sixty-nine days of treatment with folic acid. At this time the roentgenograms showed an almost complete reversion to normal (Fig. 10). Intestinal motility was normal, the barium reaching the cecum in two hours, the mucosa was only



FIG. 10. Case III.

slightly edematous in several small areas and there was a minimum of segmentation of the column of barium.

CASE IV (C. C.) had classical tropical sprue in relapse. His first series of gastrointestinal roentgenograms were taken on January 2, 1946, before any treatment was given. Figure 11 shows segmentation of the barium, alternating intestinal spasm and dilatation, edema of the mucosa of the jejunum, and atrophy of the mucosa of the ileum. Intestinal hypomotility was severe. On February 16, 1946, after eighteen days of treatment with folic acid in daily oral doses of 10 mg., a second series of roentgenograms were taken. Most of the alterations described above in the baseline roentgen series were present in this series also, but to a much



FIG. 11. Case IV.

less degree (Fig. 12). Intestinal motility was improved, the barium reaching the cecum in less than four hours. On April 12, 1946, after



FIG. 12. Case IV.



FIG. 13. Case IV.

seventy-two days of treatment with folic acid a third series of roentgenograms were taken. The mucosa of the small intestine was essentially normal but there were still a few areas of isolated intestinal spasm and dilatation (Fig. 13). Intestinal motility was greatly improved, the barium having reached the cecum in one and one-half hours.

CONCLUSION

Synthetic folic acid in daily oral doses of 10 mg. has a profound effect on the alimentary tract function of patients with tropical

sprue in relapse. Repeated roentgen studies on Case II, who had tropical sprue but who did not receive folic acid, showed no improvement within a similar period of time. In contrast to this positive control, Cases III and IV showed striking improvement which was evidenced by return of intestinal motility toward normal and the establishment of a continuous column of barium which was not interrupted by segmentation or fragmentation. The roentgenographic findings most often observed in this series of patients with tropical sprue are mucosal edema, intestinal segmentation with alternating intestinal spasm and dilatation and intestinal hypomotility. These abnormal roentgen-ray patterns could very well be the result of nutritional disorder, hypoproteinemia, disease of the liver, disease of the mesentery, or any disease condition which may produce submucosal edema,³ but in these cases the response to synthetic folic acid was dramatic.

REFERENCES

1. VILTER, C. F., SPIES, T. D., and KOCH, MARY B. Further studies on folic acid in the treatment of macrocytic anemia. *South. M. J.*, 1945, 38, 781-785.
2. SPIES, T. D., MILANES, FERNANDO, MENENDEZ, ARISTIDES, KOCH, MARY B., and MINNICH, VIRGINIA. Observations on the treatment of tropical sprue with folic acid. *J. Lab. & Clin. Med.*, Feb., 1946, 31, 227-241.
3. GOLDEN, ROSS. Radiologic Examination of the Small Intestine. J. B. Lippincott Company, Philadelphia, 1945.



RETICULO-ENDOTHELIOSIS

WITH REPORT OF TWO CASES*

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SINGLE or multiple granulomatous lesions of bone with or without soft tissue involvement, diabetes insipidus or exophthalmos, have been variously classified as certain forms of xanthomatosis, Hand-Schüller-Christian's disease, Letterer-Siwe's disease, lipoid histiocytosis, lipoidosis, lipoid granulomatosis, eosinophilic granuloma, solitary granuloma and reticulo-endotheliosis.

There have been many varied explanations given as to the causative factors in this group of diseases. The Hand-Schüller-Christian syndrome occurs more commonly than other members of this group. At first it was believed that this condition was due to a pituitary dysfunction. Rowland's²⁷ investigations in 1928 led him to believe that the findings were primarily those of a disturbed lipid metabolism and that the resulting granulomatous lesions were a hyperplastic reaction of the reticulo-endothelial system produced by a lipid infiltration. He felt that the primary causative factor was an excess ingestion of fatty foods. Sosman³⁰ classified xanthomatosis as a disease of lipid metabolism and subdivided it into five clinical entities: (Gaucher's disease; Niemann-Pick's disease; Schüller-Christian's disease; xanthomas occurring in diabetes, icterus, and pregnancy; and essential xanthomatosis). Chester and Kugel² described these lesions as non-infectious bacterial inflammatory granulomata due to the deposition of various lipid substances in the involved areas. Teperson³³ also felt that xanthomatosis represented a constitutional disturbance of fat metabolism with a storage of excess fats in the reticulo-endothelial and histiocytic systems. Hilton and Eden¹⁵ expressed a similar opinion.

Sosman³¹ stated that the essential for producing xanthomatosis was either a hypercholesterolemia or a normal body fluid cholesterol with traumatized or suppurative areas capable of storing it as a foreign body. He stated that the characteristic xanthoma or "foam cells" were not always observable. Thannhauser³⁴ felt that this group of diseases was a heredofamilial constitutional disorder of the intracellular metabolism, and that the substances accumulated in the cell were not supplied by the blood stream but were a result of disturbances in the cellular lipid metabolism.

As early as 1934, Grady and Stewart¹⁰ stated that a relationship between non-lipoid histiocytosis and Hand-Schüller-Christian's disease might exist. Strong³² (1936) expressed the opinion that the reticulo-endothelial system probably played a large part in these diseases and questioned the existence of a definite relationship with lipid metabolism.

Other investigators^{13,14,35} proposed that these clinical entities were not necessarily disturbances of lipid metabolism and preferred to classify them as primary diseases of the reticulo-endothelial system. It was felt that they represented variants of the same basic disease process and that there were insufficient grounds to warrant their separation into specific disease entities. This view was not supported by Lichtenstein and Jaffe²² who coined the term "eosinophilic granuloma" to classify single granulomatous lesions of bone as a distinct disease entity not related to xanthomatosis.

Currens and Popp⁴ stated that the etiology was obscure but mentioned that the pathology frequently suggested that the disease might be an infectious type of granuloma. The finding of large amounts

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of lipoid in some of the lesions has been the main evidence for regarding Hand-Schüller-Christian's disease as a lipoid metabolic disorder. Cowie and Magee³ made a study of the lipoid content of various tissues in a case of Hand-Schüller-Christian's disease and in a control case of similar age and anemia. They found no essential differences in the lipoid content of the tissues with the exception of the xanthomatous masses. Gross and Jacox¹³ felt that Hand-Schüller-Christian's disease was a chronic form of reticulo-endotheliosis and that Letterer-Siwe's disease was an acute type of the same disease process.

CLINICAL FINDINGS

All the clinical signs are dependent on the location of the granulomatous masses and may be extremely variable. The involvement can differ between the extremes of a single bone lesion to generalized bone and soft tissue involvement. Early investigators mentioned that the triad of "skull defects, exophthalmos, and diabetes insipidus" were necessary for a diagnosis of Hand-Schüller-Christian's syndrome. Later it was found that any combination of these may be present and not infrequently all three so-called "essentials for diagnosis" were absent.

Headaches and localized areas of scalp tenderness are two of the more common findings. Defects in the mandible associated with gingivitis and loosening of the teeth are often present. Dalitsch⁵ mentioned the frequency of oral lesions as a late manifestation of this disease. It has been noted that cutaneous lesions may occur rather frequently.²⁰ Occasionally a lymphadenopathy may be the initial finding.^{9,19} Enlargement of the liver and spleen has been reported.

It has been generally agreed that when diabetes insipidus is present it is a result of granulomatous infiltration of the hypophysis and tuber cinereum. Rowland²⁸ reported that with involvement of the pituitary gland, destructive changes in the sella were found in less than one-third of the cases. In younger individuals, signs of hypopituitar-

ism (diabetes insipidus, dwarfism and adiposogenital dystrophy) are not an uncommon finding.

In those cases where there is considerable pulmonary involvement, the main complaints may be those of weakness, loss of weight, coughing and chest pain. In a recent report Currens and Popp⁴ stated that pulmonary fibrosis is rarely associated with these cases but other authors have reported that it occurs rather frequently.^{2,3,23,27,29}

There have been a number of cases where the initial finding, usually diabetes or a solitary bone lesion, has been present for many years prior to the development of generalized involvement. Davison⁷ reported a case of a male, aged twenty-seven, whose complaints started at the age of twenty-two with pain and falling out of teeth. Diabetes insipidus developed at the age of twenty-five and neurological symptoms at the age of twenty-eight. The patient died of a pulmonary infection at the age of thirty. Dauksys⁶ reported a case of a white male, aged thirty-seven, who had had a polyuria since the age of twenty-one. Hilton and Eden¹⁵ report a case of xanthomatosis in which diabetes insipidus persisted for six years prior to the development of defects in the skull, femur and mandible.

Xanthomatous infiltration may simulate a mastoiditis. Exophthalmos, when present, is due to involvement of the bony orbits and not to increased intracranial pressure. The exophthalmos may be unilateral. Available literature shows a frequency of approximately 2 to 1 in males but does not reveal any apparent racial tendency.

For a long time xanthomatosis was thought to be primarily a disease of the first decade but this is not a disease confined to childhood. Recently more cases in adults have been reported. Spontaneous remissions may occur in both the single and multiple lesions.^{11,13,25,23} Disappearance of untreated pulmonary infiltration has never been observed.

LABORATORY FINDINGS

A review of the literature fails to show

any constancy in the laboratory findings that might be of value in diagnosing this group of diseases. Leukocytosis has been reported in a number of cases. An increase in the blood cholesterol level has been given considerable significance by some authors but numerous cases have been reported where the blood cholesterol values remained essentially within normal limits. Dauksys⁶ in a rather detailed review of the literature found that 50 per cent of the reported cholesterols were above 230 mg. per 100 cc. of blood. The serum calcium, phosphorus, total protein, albumin-globulin ratio and phosphatase have shown no significant variations. A moderate eosinophilia has occasionally been reported. Smears and cultures from the lesions have failed to demonstrate the presence of a causative organism. Lane and Smith²⁰ reported that there were variations of lipid content in different lesions in the same patient.

Most investigators agree that there may be considerable variation in the histopathology of these granulomatous lesions. The histopathology of Hand-Schüller-Christian's disease, eosinophilic granuloma and Letterer-Siwe's disease may be so identical that differentiation is impossible.^{12,13} The granuloma may resemble a foreign body giant cell tumor or may exhibit the so-called typical xanthoma cells. Eosinophilic infiltration may be the predominant finding. Some authors^{2,20} believe that the "foam cells" are present in the early stages of the lesion and disappear during the healing phase. Green and Farber described the appearance of "foam cells" as being associated with a late stage of this process. Letterer²¹ stated that the "cholesterol infiltration merely represents a characteristic associated feature of the granulomatosis."

In a survey of the literature, Gross and Jacox¹³ analyzed 84 reported cases of Hand-Schüller-Christian's disease and found that in 26 instances neither the presence nor absence of "foam cells" was mentioned. In 9 cases, autopsy and biopsy material showed no "foam cells." Eosinophilic in-

filtration was noted in 29 of the 84 cases. In 45 cases in which the blood cholesterol level was indicated, 23 had a level above 200 mg. per 100 cc. of blood.

ROENTGENOLOGICAL FINDINGS

The bone defects are not due to a disturbance of the calcium metabolism but to pressure from the granulomatous masses. Healing of the bone lesions occurs by newly formed spongiosa with occasional osteoid or cartilaginous tissue.³³ Bass¹ mentioned that eosinophilic granuloma is an expanding lesion of bone and felt that this was a distinctive characteristic of eosinophilic granuloma as compared with Hand-Schüller-Christian's disease. Green and Farber¹¹ reported that solitary granuloma of bone does not expand the cortex and shows minimal reactive changes in the bone except in the healing phase. Rowland,²⁵ Teperson,³³ Otani and Ehrlich,²⁴ Freund and Rippes,⁹ all mention that thickening of the bone is rare in the acute form and usually occurs only in the adult or chronic form.

In early skull lesions, if two layers are involved, the defects have blurred margins and are moth-eaten in appearance. Large defects involving three layers are sharply delimited and geographic in appearance.³³ However, even with involvement of all layers the margins have an indefinite outline in the healing phase. The roentgenological appearance of the defects of Hand-Schüller-Christian's disease are similar to those found in the so-called eosinophilic granuloma or solitary granuloma of bone. Pathological fracture of a femur has been reported.²³ Lesions in the femur are not the clear-cut defects seen in the skull and resemble chronic osteomyelitis. A moderate bone reaction may be present.¹⁵ Most of the reported skeletal defects have been in the skull, pelvis, femora, and ribs. Pulmonary involvement is not infrequent and is usually spoken of as a generalized fibrosis. Nearly all of the fatal cases have shown extensive involvement of the lungs.^{23,27} In chronic cases, the pathology is largely a fibrosis but in the acute forms, it is mainly a soft

granulomatous infiltration. In the healing stage of these lesions, the appearance of the lungs may suggest pneumoconiosis. In the early phase, diffuse soft infiltration may be comparable to a generalized tuberculosis or a fungus infection. The roentgen appearance of the chest can be that of numerous small emphysematous blebs resulting from an escape of air into the interstitial tissues of the lungs secondary to granulomatous destruction of the alvolar walls.^{8,20} Xanthomatous involvement of the lungs has never been observed alone or in cases of solitary lesions of bone.³⁴ Currens and Popp⁴ report that pulmonary fibrosis has rarely been seen in connection with xanthomatosis. This is contrary to the reports of other investigators.^{2,3,6,8,9,20,23,29,34}

DIFFERENTIAL DIAGNOSIS

The distribution of bone lesions is similar to that found in multiple myeloma and have frequently been mistaken for such. The lesions in the long bones, usually the femora, are not as sharply demarcated as in the skull and may be mistaken for chronic osteomyelitis. The skull defects must be differentiated from cholesteatoma, osteoporosis circumscripta, tuberculous osteomyelitis, syphilitic osteomyelitis, metastatic carcinoma and multiple myeloma. In some instances, an osteolytic lesion of the mandible is the only roentgen finding and may represent the initial bone lesion. A similar picture could be produced from a localized osteomyelitis, secondary to a root abscess or an infected cyst. History of pain and discharge from the ears may simulate a mastoiditis.

Clinical findings of a hypopituitarism may be entirely due to granulomatous invasion of the hypophysis and tuber cinereum. Cases which show a lymphadenopathy can be confused with Hodgkin's disease or tuberculosis. With massive granulomatous replacement of the bone marrow, the clinical picture is that of a severe aplastic anemia.^{14,23} Pneumoconiosis, tuberculosis and fungus infections can produce a roentgen appearance similar to

various phases of a reticulo-endothelial hyperplasia of the lungs.

TREATMENT

The early treatment of the Hand-Schüller-Christian's syndrome consisted of the use of a pituitary solution which apparently relieved the diabetes insipidus during the use of this drug. In addition, these patients were usually put on a low fat diet and, in some instances, desiccated thyroid. The results were not particularly gratifying and in 1930, Sosman³⁰ reported the beneficial use of deep roentgen therapy on skull defects. This was the beginning of what is now the accepted form of treatment for this group of diseases. Some investigators^{26,31} have reported that the filling in of the defects following roentgen treatment requires a much longer time in the chronic or adult form. Improvement in the bone lesions has been noted as early as four weeks following treatment but in some instances was not complete until eighteen months following therapy. Very few cases have been reported where there has not been a favorable response to deep roentgen therapy. The recently described solitary lesion of bone has also responded well to roentgen therapy.¹² Most authors reporting the use of deep roentgen therapy state that there has been a rapid symptomatic response. In some instances the lesions have been treated by curettage. Some of these have shown no improvement following the operation and recurrences have occurred. Teperson³³ reports a case of a cranial defect above the right orbit which was surgically excised and recurred four months after operation. One and one-half years later there was generalized bony involvement. Roentgen treatment was given to the parathyroids but the defects continued to increase in size. Deep roentgen therapy was subsequently given to the skull and ilium and the cranial defects began to recede at the end of four weeks.

Reports of the treatment of pulmonary lesions are rare. Kartagener and Fischer¹⁷ were of the opinion that irradiation of the

lungs made the fibrosis worse. Currens and Popp⁴ reported a case treated with a total dose of 270 r at 130 kv. with marked improvement in the bone lesions. This patient exhibited pulmonary fibrosis which was treated with deep roentgen therapy. Slight improvement of the treated portions was noted. One side of the chest was treated and the opposite side was used as a control.

Jones¹⁶ reported a single case which showed reossification in one to four months following roentgen therapy. He was of the opinion that the longer the lesions are present prior to treatment, the slower the reossification. Wortis, Wolf and Dyke³⁶ reported 2 cases treated with deep roentgen therapy using small doses (300 r) with regression of the lesions in six weeks. Kellogg¹⁸ reports a case of a single lesion in the skull treated with roentgen therapy, dosage not stated, with almost complete healing in one and one-half years.

Irradiation of pituitary gland to control the diabetes has met with varying degrees of success. Obviously little improvement can be anticipated where the involvement is no longer in the granulomatous stage but has gone on to fibrosis.

It is noteworthy that many of the reports



FIG. 1. Case 1. Lateral projection of the skull demonstrating multiple irregular areas of bone destruction particularly in the left parietal and occipital bones.



FIG. 2. Case 1. Skull examination seventeen weeks after completion of roentgen therapy showing considerable filling in of the bone defects.

in the literature do not satisfactorily describe the amount or type of roentgen therapy administered.

REPORT OF CASES

CASE 1. White, male, aged twenty-four, was admitted to Letterman General Hospital, May 4, 1944, complaining of polydipsia and polyuria which had existed since February, 1943. He had lost approximately 12 pounds in weight.

Past history disclosed an appendectomy in 1924 at the age of four years, and submucous resection in December, 1943. Patient sustained a fracture of the left little finger in 1925. No further history of illness or accident.

Patient entered military service on February 18, 1941. At that time he states that he was in good health with no complaints. While on a routine flight in January, 1943, the plane dropped about 200 feet and the patient struck his head on the canopy. He was not unconscious, but a headache was noted which lasted for four days. It was following this headache that an increase in thirst was first noted. The patient also noted a gradual loss of weight during this time.

In February, 1943, he was hospitalized and a routine roentgenogram of the chest revealed a pneumonitis of the left lung. Patient had no pulmonary complaints. He stated that during exercise periods, he seemed to "burn up" and could not perspire and that he passed out three times from heat exhaustion. The polydipsia

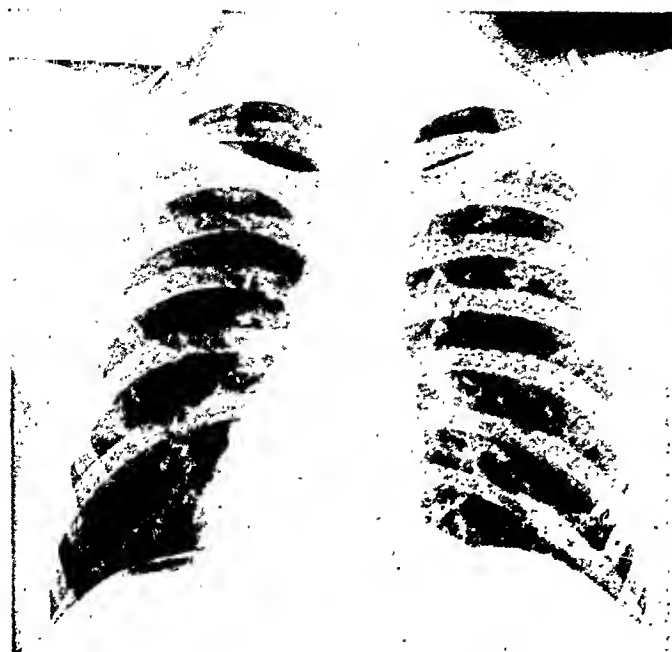


FIG. 3. Case 1. Posteroanterior projection of chest showing extensive fibrosis throughout both lungs, slightly more marked on the right.

and polyuria persisted but other than this the patient was asymptomatic.

One year later the patient was again hospitalized for a persistence of the pulmonary infiltration and was later transferred to Letterman General Hospital.

On admission the patient was a well developed and well nourished white male showing no abnormal physical findings with the exception of several small areas of scalp tenderness in the left parietal and occipital regions.

A complete roentgenological survey revealed the following findings: At the junction of the proximal and middle thirds of the left femur, there were about 15 small indefinite and irregular areas of decreased density, none of which exceeded 5 mm. in diameter and were associated with a moderate increase in the thickness and density of the cortex. There was a resultant increase in the diameter of the femur in this area. A roentgenogram of the chest showed extensive soft infiltration and fibrosis throughout both lungs, slightly more marked on the right. There were no other significant findings. Roentgenograms of the skull showed multiple irregular areas of bone destruction most of which were located in the left half of the skull and in the occipital region. One spherical area of bone destruction measuring 2 cm. in its greatest diameter was located in the right frontal bone. This defect was much smoother in outline, as compared with the other skull

lesions. The defects in the left parietal region were markedly irregular in outline and had less definite margins. The areas of bone destruction in the occipital region were the least prominent. There was no bone reaction about any of the skull defects. The sella was normal in appearance.

Laboratory findings were as follows: Urinalyses showed a persistently low specific gravity varying between 1.000 and 1.007 and repeated examinations for Bence-Jones protein were negative. Blood chemistry studies. Serum protein 7.2 mg.; serum albumin 3.4 mg.; serum phosphorus 4.1 mg.; serum calcium 10.7 mg.; alkaline phosphatase 2.1 Bodansky units; the cholesterol level showed very little variation, 254 to 259 mg.; cholesterol esters varied between 200 and 210 mg. Blood counts remained within normal limits.

On May 15, 1944, a biopsy of skull lesions was done under local procaine infiltration anesthesia. An incision was made in the occipital region just above the external occipital protuberance and about in the midline. A grayish, granular appearing material was seen extruding from the defect in the skull. This material was curetted away and it was found that both tables of the skull had been involved and the defect went through to the dura.

Pathological Report. The specimen consists of several small hemorrhagic, yellowish and brownish fragments of tissue.

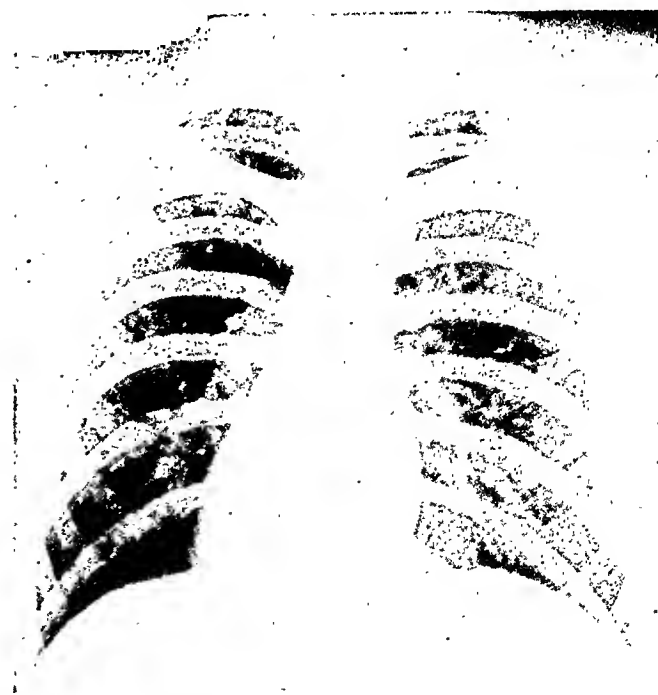


FIG. 4. Case 1. Chest examination twenty and one-half weeks later shows very slight improvement.

Microscopic: The specimen is composed of inflammatory and fibrotic granulation tissue. The cellular infiltrate consists of two chief types of cells, one an eosinophile and the other a single or multinucleated histiocyte, occurring focally, diffusely and occasionally in spaces. The eosinophiles are extremely numerous and of the mature type. The histiocytes are single and multinucleated. The nuclei are small and large, irregular in outline, vesicular, often indented or folded and contain a well defined nucleolus. There are sometimes as many as twelve or more nuclei scattered about the periphery or concentrated in the center of the cell. The cytoplasm stains deeply and shows considerable phagocytosed material including stainable lipoids; pigment and cellular debris, particularly eosinophiles in part or in whole. The granulation tissue is fairly well preserved but shows areas of hemorrhage and coagulation necrosis. The vacuolar fatty changes are most pronounced in the degenerated areas. There are



FIG. 6. Case 11. Posteroanterior projection of the chest shows a diffuse soft infiltration in both lungs and an area of bone destruction in the posterior portion of the left fifth rib.

no large sheets of viable xanthomatous cells. The fibroblasts of the stroma are mature. The granulation tissue is rich in capillaries. There are a few infiltrated small lymphocytes. There is no evidence of bone. Impression: Chronic granulomatous lesions of skull with numerous eosinophiles and single and multinucleated macrophages containing moderate amounts of stainable lipid.

CASE 11. White, male, aged twenty-seven, was admitted to Letterman General Hospital on April 10, 1944, complaining of pains in the left chest aggravated by deep breathing and a tender spot just to the right of the symphysis of the mandible. Patient also complained of some indefinite pain in the region of the right hip.

Past history disclosed no previous illness with the exception of an attack of the mumps in childhood.

Patient entered military service on October 3, 1942. While enroute to the Southwest Pacific Area in May, 1943, he fell and injured his right hip. There was no particular discomfort until about three weeks later when he noticed the onset of sharp pains in the right hip, particularly while walking. At rest he noticed a constant aching in that region. There were no

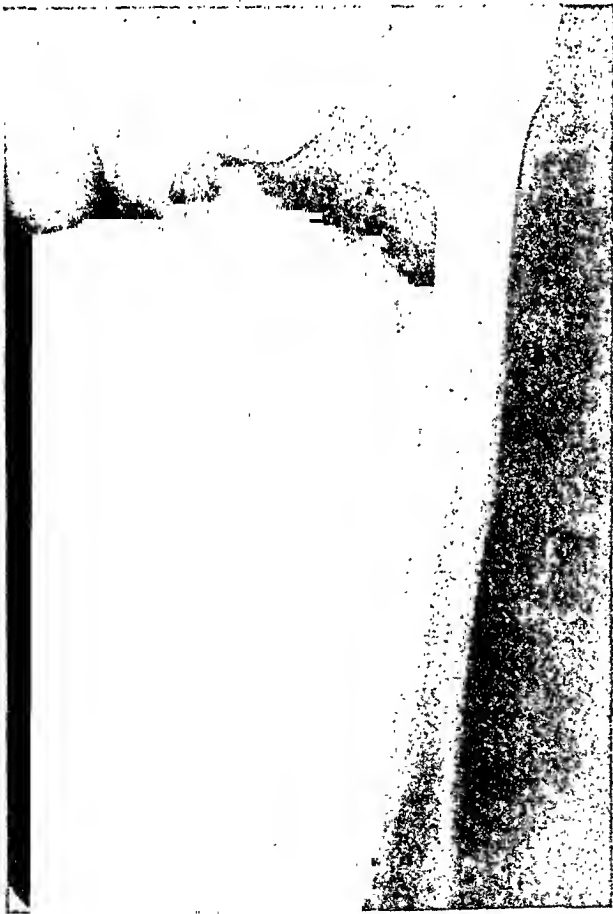


FIG. 5. Case 1. Multiple small defects in the left femur with thickening of the cortex and expansion of the bone. There was no demonstrable change subsequent to roentgen therapy.

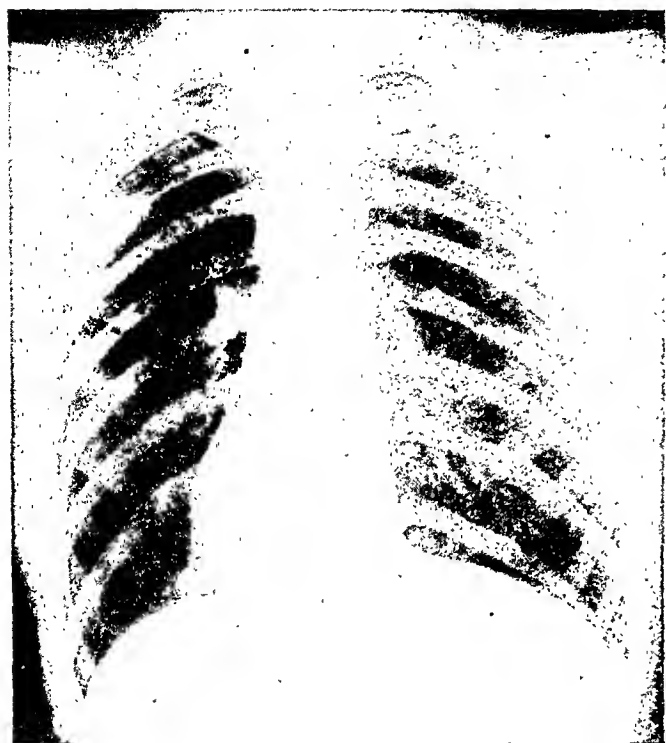


FIG. 7. Case II. Chest examination seventeen and one-half weeks later showing marked clearing of the chest. Roentgenogram taken sixteen weeks following treatment to the right chest and four and one-half weeks following treatment to the left chest.

fevers, chills or involvement of other joints. During August, 1943, he was hospitalized for three weeks because of this discomfort. In October, 1943, he was hospitalized again be-



FIG. 8. Case II. Lateral projection of the skull shows multiple sharply circumscribed areas of bone destruction in the right parietal and occipital bones.

cause of malaria, having had three serious paroxysms. During November, 1943, he started complaining of slight sticking pains in the left chest aggravated by deep breathing. One month later he noted a tender spot just to the right of the symphysis of the mandible. Roentgen evidence of a bilateral pneumonitis resulted in his admission to a hospital. During his six weeks of hospitalization, he began to complain of mild pain and looseness of the right lower teeth. Roentgenogram of the mandible disclosed an osteolytic process in this area and the six lower anterior teeth were removed.

On February 8, 1944, he was admitted to a general hospital where the following findings were obtained: (1) a mild evening fever was present throughout his eight weeks of hospitali-



FIG. 9. Case II. Skull examination twenty-three and one-half weeks later with an almost complete filling in of one of the defects and more indefinite margins to the remaining defects. A new area of bone destruction is noted in the left frontal bone.

zation; (2) the liver was found to be enlarged; (3) roentgen evidence of localized osteolytic processes in the fifth left rib posteriorly, numerous areas in the skull, the anterior portion of the right side of the mandible and the pelvis. A roentgenogram of the chest showed extensive soft infiltration in both lungs which was thought to be a moderately advanced bilateral pulmonary tuberculosis. Specimens were obtained from the left fifth rib and the skull.

Laboratory findings during this time were as follows: Bence-Jones protein, serum calcium,

repeated blood cultures and repeated smears and cultures of the sputum for tuberculosis and fungi were negative. The only significant laboratory finding was a high blood cholesterol which varied between 235 and 288 mg. A specimen of sternal marrow was obtained and showed no significant findings. Smears and cultures from the operative areas were entirely negative.

Pathological Report. The specimen consists of many irregular fragments of soft grayish-white tissue.

Microscopic: For the most part, the cells are peculiarly lobulated, large mononuclear type,



FIG. 10. Case 11. Irregular areas of bone destruction in the right sacroiliac region.

a few of which contain nucleoli and some of which resemble epithelioid cells. There are a number of phagocytes containing erythrocytes, brown pigment probably hemosiderin, and lipid droplets. Numerous eosinophiles, both diffuse and focal in location, are scattered throughout. There are a few small giant cells with two or three nuclei, many of which contain phagocytosed material. A few scattered mitotic figures are seen. Necrosis and hemorrhage are noted. Scarring and fibroblastic reaction is minimal. Impression: eosinophilic granuloma.

On admission to Letterman General Hospital, the patient showed evidence of a moderate loss of weight and localized areas of tenderness in the anterior portion of the right side of the mandible, the left fifth rib posteriorly and the right parietal and occipital areas. Liver and spleen were not enlarged.



FIG. 11. Case 11. Recheck roentgenogram shows almost complete healing of the defects in the right sacrum and ilium.

Further laboratory studies revealed a normal sedimentation rate; blood cholesterol levels ranging between 250 and 256 mg; repeated urinalyses and blood counts to be within normal limits and a negative serological test for coccidioid infection.

Roentgenological studies showed the following findings: There was extensive soft patchy infiltration throughout the upper two-thirds of both lungs. A cyst-like area of bone destruction was present in the posterior portion of the left



FIG. 12. Case 11. Irregular area of bone destruction in the anterior portion of the right mandible.

fifth rib and measured approximately 3 cm. in its greatest diameter. There was moderate expansion of the rib in this area. Many of the other ribs exhibited small irregular indefinite defects. The distal half of the right wing of the sacrum and the adjacent portion of the ileum contained multiple irregular areas of bone destruction, the margins of which showed no bone reaction. There were several small areas of decreased density in the right pubis which probably represented early changes of the same process. Multiple sharply delimited areas of bone destruction involved the right parietal, temporal and occipital bones. The largest of these defects measured 4 cm. in diameter. Roentgenogram of the right mandible disclosed a single large defect just anterior to the mental foramen.

A specimen was again obtained from the occipital region of the skull with the following microscopic findings: Sections show a moderately dense fibrous background which, in some regions, is densely infiltrated with many different types of cells. There is a distinct predominance of eosinophilic leukocytes in some regions. In other places, the lymphocytes stand out sharply. Associated with these two types of cells are sheets of large mononuclear cells that have a prominent, somewhat vesicular nucleus in which there is a large basophilic nucleolus. These phagocytic cells are occasionally multinucleated. Sometimes, they have a vacuolated cytoplasm. Pigment may be present in the cytoplasm. An occasional mitotic figure is noted. An occasional large blood vessel is present but there is nothing unusual about the general vascular network. Cultures prepared from the material at the time of surgery showed no growth in any of the media inoculated. Routine typhoid-paratyphoid agglutinations were set up with the patient's serum and were negative. In addition, several *Salmonella* antigens were used, particularly strains of typhimurium and these were negative. Diagnosis: Eosinophilic granuloma of bone.

TREATMENT

CASE 1. In view of the marked elevation of the fluid intake and output, it was decided to first irradiate the pituitary gland. Daily treatments were given on four successive days using right and left 7 by 7 cm. fields. Both fields were treated daily and received 100 r with the following factors: 200 kv.; 0.5 mm. copper and 1 mm. aluminum added infiltration; half-value layer

0.9 mm. copper; 50 cm. skin-target distance and 28.5 r per minute in air. A total dose of 400 r was delivered to each field. Treatments were begun on May 20, 1944.

A 7 by 7 cm. field was directed to the right side of the skull and a 10 by 10 cm. field to the occipital region. These areas received 100 r every other day for a total of 400 r to each field. Treatments were begun on May 25, 1944.

An anterior and a posterior field, each measuring 15 by 15 cm. were directed to the involved area in the left femur. Each area received 200 r on alternate days for a total of 600 r to each field. This series of treatment was instituted on May 31, 1944.

A series of deep roentgen therapy to the right chest was instituted on June 1, 1944, using two anterior and two posterior fields all of which measured 15 by 15 cm. A single field was treated daily and received 200 r per treatment. Each area received a total of 600 r. The left side of the chest was then treated in a similar manner beginning August 7, 1944, and each of these fields also received a total of 600 r. The same physical factors were used for treatment of all areas.

All roentgen dosages refer to air measurements.

CASE II. Two 7 by 7 cm. fields over the anterior portion of the right mandible and the right temporo-parietal region and a 15 by 15 cm. occipital field were treated every other day with the same factors as in Case 1. The three areas received 100 r every other day for a total of 400 r to each field. Treatments were instituted on May 12, 1944.

A single 15 by 15 cm. posterior field was used to treat the destructive lesion in the right sacroiliac region. Daily treatments of 100 r were given for a total of 400 r to this field. Treatments were begun on May 26, 1944.

On May 30, 1944, a series of deep roentgen therapy to the right chest was instituted using two anterior and two posterior fields, each of which measured 15 by 15 cm. A single field was treated daily and received 200 r per treatment. Each field received a total dose of 600 r.

A second series of treatments to the right sacroiliac region were instituted on June 13, 1944, and the same dosage repeated.

On August 7, 1944, a series of deep therapy treatments to the left side of the chest were begun and treatments given in exactly the same manner as on the right side of the chest.

On September 6, 1944, a single 7 by 7 cm.

portal was directed to the new lesion that developed in the superior aspect of the left frontal bone. Daily treatments of 100 r were given for a total of 300 r to this area.

All roentgen dosages refer to measurements in air.

RESULTS OF THERAPY

CASE I. Following a series of deep roentgen therapy to the pituitary gland, there was a rather prompt and marked reduction in the fluid intake and output so that at the end of one week, patient's average intake and output was 4,500 cc. per twenty-four hours as compared with 10,000 to 11,000 cc. intake and output at time of admission. Tenderness and aching of the bones rapidly disappeared while treatments were being administered to the areas of destruction. There was no apparent change in the appearance of the lesion in the proximal half of the left femur. Follow-up roentgenograms of the skull showed a marked filling in of all of the bone defects. The margins of these defects are now difficult to trace. The roentgenogram of the chest showed very slight improvement. There was some regression of the small patchy areas of soft infiltration but the extensive areas of fibrosis were relatively unchanged in appearance.

CASE II. There has been a marked clearing of the chest with a minimal amount of residual fibrosis. The defect in the left fifth rib was slightly larger in size but this was attributed to the fact that the left side of the chest was not treated until two months after roentgen therapy had been given to the right side of the chest. A roentgenogram of the pelvis showed a marked filling in of the bone defects which now exhibit a small zone of osteosclerosis about their margins. Roentgenograms of the skull demonstrated considerable filling in of the defect in the right temporal bone and less sharply demarcated borders of the remaining defects. A new area of bone destruction measuring 1.5 cm. in diameter was noted in the posterior portion of the superior aspect of the left frontal bone. This patient also exhibited early relief of pain and tenderness in the treated areas.

SUMMARY AND CONCLUSIONS

The separation of Hand-Schüller-Christian's disease, eosinophilic granuloma or solitary granuloma of bone and Letterer-Siwe's disease into specific disease entities

is not valid on the basis of the evidence at hand.

There are insufficient data to support the claim of a lipid metabolic disorder as the primary causative factor. There are no pathological or roentgenological findings that warrant classifying these syndromes as individual diseases. It is felt that all these processes are variants of a hyperplastic reaction of the reticulo-endothelial system and can be properly grouped under the term reticulo-endotheliosis. Eosinophilic granuloma or solitary granuloma of bone represents a localized or focal hyperplasia of the reticulo-endothelial system.

The stage of the disease process in the hypophysis and tuber cinereum will determine the response of the diabetes insipidus to roentgen therapy. Little or no improvement will occur if the infiltration is in the stage of fibrosis.

The pulmonary pathology is comparable to that found in the bones which, in its early stages, is a granulomatous process and in the healing phase is almost entirely fibrosis. Pulmonary involvement in the early phase responds to deep roentgen therapy but lesions that have gone on to fibrosis show very little change.

Satisfactory response of the bone, pituitary and pulmonary lesions can be obtained with relatively small doses of roentgen radiation. In the two cases reported, 600 r, measured in air, to any one field was exceeded on only one occasion. None of the skull lesions received more than 400 r, measured in air, through any one field.

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REFERENCES

1. BASS, M. H. Solitary eosinophilic granuloma of bone. *Am. J. Dis. Child.*, 1941, 61, 1254-1262.
2. CHESTER, W., and KUGEL, V. H. Lipoidgranulomatosis (type, Hand-Schüller-Christian). *Arch. Path.*, 1932, 14, 595-612.
3. COWIE, D. M., and MAGEE, M. C. Lipoids and lipid diseases. *Arch. Int. Med.*, 1934, 53, 391-399.

4. CURRENS, J. H., and POPP, W. C. Xanthomatosis—Hand-Schüller-Christian type; report of case with pulmonary fibrosis. *Am. J. M. Sc.*, 1943, 205, 780-785.
5. DALITSCH, W. W. Xanthomatosis—Schüller-Christian's disease. *Illinois M. J.*, 1933, 63, 131-137.
6. DAUKSYS, J. Xanthomatosis: Schüller-Christian's disease. *J. Missouri M. Ass.*, 1935, 32, 466-473.
7. DAVISON, C. Xanthomatosis and the central nervous system (Schüller-Christian syndrome). *Arch. Neurol. & Psychiat.*, 1933, 30, 75-98.
8. FARBER, S. Case records of the Massachusetts General Hospital. *New England J. Med.*, 1942, 226, 394-395.
9. FREUND, M., and RIPPS, M. L. Hand-Schüller-Christian disease. *Am. J. Dis. Child.*, 1941, 61, 759-769.
10. GRADY, H. G., and STEWART, H. L. Hand-Schüller-Christian's disease and tuberculosis. *Arch. Path.*, 1934, 18, 699-709.
11. GREEN, W. T., and FARBER, S. "Eosinophilic or solitary granuloma" of bone. *J. Bone & Joint Surg.*, 1942, 24, 499-526.
12. GREEN, W. T., and FARBER, S. A recently defined destructive lesion of bone. *New England J. Med.*, 1941, 224, 832.
13. GROSS, P., and JACOX, H. W. Eosinophilic granuloma and certain other reticulo-endothelial hyperplasias of bone. *Am. J. M. Sc.*, 1942, 203, 673-687.
14. HERTZOG, A. J., ANDERSON, F. G., and BEEBE, G. W. Reticuloendotheliosis with lipid storage. *Arch. Path.*, 1940, 29, 120-124.
15. HILTON, E. L. G., and EDEN, K. Xanthomatosis of the skeleton in an adult (lipoidosis of Schüller-Christian type). *Lancet*, 1941, 1, 782-784.
16. JONES, A. B. Schüller-Christian's disease; report of case in one of identical twins. *Ann. Int. Med.*, 1939, 13, 1068-1075.
17. KARTAGENER, M., and FISCHER, G. Cited by Dauksys.⁶
18. KELLOGG, D. S. Xanthomatosis (lipoidosis, Schüller-Christian type). *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 44, 396-400.
19. KENNEDY, R. L. J. Xanthomatosis: Schüller-Christian's disease. *Proc. Staff Meet., Mayo Clin.*, 1938, 13, 776-781.
20. LANE, C. W., and SMITH, M. G. Cutaneous manifestations of chronic (idiopathic) lipiodosis (Hand-Schüller-Christian disease). *Arch. Dermat. & Syph.*, 1939, 39, 617-644.
21. LETTERER, E. Cited by Freund and Ripps.⁹
22. LICHTENSTEIN, L., and JAFFE, H. L. Eosinophilic granuloma of bone. *Am. J. Path.*, 1940, 16, 595-604.
23. LICHTY, D. E. Lipoids and lipid diseases; xanthomatosis. *Arch. Int. Med.*, 1934, 53, 379-390.
24. OTANI, S., and EHRLICH, J. C. Solitary granuloma of bone simulating primary neoplasm. *Am. J. Path.*, 1940, 16, 479-490.
25. RADDING, M. B. Schüller-Christian disease after x-ray therapy, living and under observation eleven years. *Radiology*, 1935, 24, 591-600.
26. REICH, S. Xanthomatosis and Schüller-Christian syndrome. *Canad. M. Ass. J.*, 1934, 31, 256-265.
27. ROWLAND, R. S. Xanthomatosis and reticulo-endothelial system. *Arch. Int. Med.*, 1928, 42, 611-674.
28. ROWLAND, R. S. Schüller-Christian's disease. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1933, 30, 649-656.
29. SMITH, L. A. Xanthomatosis involving bone (lipoid histiocytosis). *Radiology*, 1935, 24, 521-534.
30. SOSMAN, M. C. Xanthomatosis (Schüller's disease; Christian's syndrome). *AM. J. ROENTGENOL. & RAD. THERAPY*, 1930, 23, 581-597.
31. SOSMAN, M. C. Xanthomatosis (Schüller-Christian's disease; lipid histiocytosis). *J. Am. M. Ass.*, 1932, 98, 110-117.
32. STRONG, R. A. Xanthomatosis (Schüller-Christian's disease). *J. Am. M. Ass.*, 1936, 107, 422-426.
33. TEPERSON, H. I. Xanthomatosis. *Radiology*, 1935, 25, 440-450.
34. THANNHAUSER, S. J. Lipidoses: Diseases of the Cellular Lipid Metabolism. Edited by Henry A. Christian. Oxford University Press, New York, 1940.
35. VERSIANI, O., FIGUEIRO, J. M., and JUNQUEIRA, M. A. Hand-Schüller-Christian's syndrome and "eosinophilic or solitary granuloma of bone." *Am. J. M. Sc.*, 1944, 207, 161-166.
36. WORTIS, S. B., WOLF, A., and DYKE, C. G. Xanthomatosis and the syndrome of diabetic exophthalmic dysostosis. *Am. J. Dis. Child.*, 1936, 51, 353-356.



ROENTGENOLOGICAL EXAMINATION OF THE POWER OF RESISTANCE OF THE TRACHEAL WALL

AN IMPORTANT SIGN IN TREATMENT OF TRACHEAL STENOSIS

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THE trachea is a hollow cylinder filled with air embedded in organs of greater density. Therefore it must be visible in the roentgenogram. A roentgen examination based on the representation of the trachea in two positions, perpendicular to each other—in anteroposterior and lateral positions—must give a true picture of the changes in position and shape of the trachea. The roentgen examination of the trachea in these two positions makes it possible to recognize whether the trachea has undergone any change in its position and whether a stenosis is present. These facts are of great importance when considering pathology and therapy of the case in question.

In examining the trachea in the lateral position the patient lies on his side on the table, his shoulders bent backward as far as possible. The patient is fixed in this position. His head is supported at the natural level by sand bags. The central ray is projected to the clavicle nearest the film, aiming at the center of the film.

In addition to roentgenography, roentgenoscopy plays an important part. In roentgenoscopy the patient should turn slowly. In this way roentgenoscopy will show the trachea most clearly at the moment when the central ray passes the longest diameter of the tracheal stenosis. Thus roentgenoscopy (complementary to roentgenography) allows important conclusions about the kind of the tracheal stenosis and particularly in cases in which the pressure on the trachea takes place in an oblique direction.

By means of the roentgen examination we can recognize displacements, deviations and stenoses of the trachea in a much more simple and exact way than by laryngological methods. On the other hand, the roent-

genological examination will not inform us about other questions (condition of the mucous membrane, disturbances in innervation, etc.) which can be ascertained easily by laryngological examination.

Displacements and stenoses of the trachea are most frequently observed in patients with goiter. An objective determination of the question whether difficulties in breathing are due to pressure of the goiter on the trachea is important; because it is well known that dyspnea in patients with goiter is not necessarily caused by stenosis of the trachea but may be due to a pathological condition of other organs, particularly of the heart and lungs. The operative removal of a goiter in a patient where the difficulties in breathing have been erroneously attributed to a tracheal stenosis would do great damage to the patient and would be a serious mistake.

A well known fact is the frequent and striking disproportion between the degree of the tracheal stenosis and the degree of the dyspnea. Especially patients with slowly growing goiters and gradually increasing pressure on the trachea will become accustomed to the difficulties in respiration to such an extent that they will scarcely become aware of any serious trouble. No doubt these patients are in constant danger as a slight swelling of the mucous membrane in the area of the stenosis may produce serious difficulties in breathing and suffocation.

The roentgen examination made according to the above mentioned technique offers without any difficulty an objective judgment on the condition of the trachea. At the same time it will give us an explanation about a possible presence of an intrathoracic goiter, about the condition of the heart and the lungs. Roentgenoscopy, con-

secutive to roentgenography, will show whether or not the intrathoracic portion of the goiter rises in swallowing and coughing. This differentiation is of great importance as indication for the kind of treatment. A lack of mobility reveals presence of adhesions with the neighboring tissues which may make an operative removal of the goiter very difficult (danger of gas embolism, asphyxia, mediastinal emphysema, etc.).

With the statement of the kind of displacement and change in shape of the trachea, the efficiency of the roentgen examination in pathological conditions of the trachea is by no means completed. In addition it further offers a *knowledge of the condition of the tracheal wall*. It allows a critical examination of the *power of resistance and firmness of the cartilaginous rings of the trachea*. The power of resistance of the tracheal wall is very frequently weakened by a long lasting pressure exerted by the goiter. The firmness of the cartilaginous rings of the trachea, their power of resistance may decrease by the pressure of a long existing goiter causing a great danger for the patient. The cartilaginous tissue of the tracheal rings may in some places partly or completely disappear. Thus the dreaded and dangerous pathological feature of a *malacia of the trachea* may develop. This softening of the cartilaginous rings of the trachea may cause sudden death by suffocation due to collapse of the trachea.

Malacia of the trachea is not infrequently observed in goiters of adults which have existed for many years, particularly in hard fibrotic goiters, sometimes also in recent goiters of young people. Very often malacia of the trachea is also observed in malignant goiters.

The knowledge of the condition of the wall of the trachea in patients with goiter is of the greatest importance as in this way we learn to judge the degree of danger to the patient arising by the tightening of the trachea by the goiter.

Between normally preserved cartilagi-

nous tracheal rings and pronounced malacia all transitional stages of softening of the tracheal wall may be observed. The roentgen examination easily demonstrates the serious and dangerous pathological features of malacia which mean an absolute indication for operative removal of the goiter.

The softening and weakening of the tracheal rings is easily diagnosed by a change in width of the tracheal lumen in intratracheal increase and decrease of air pressure^{1,2} *Malacia of the trachea in the area of the stenosis can be recognized without any difficulty by great enlargement of the tracheal lumen in increased intratracheal air pressure and by a very marked narrowing in decreased intratracheal air pressure.*

For an increase in intratracheal air pressure the experiment of Valsalva is used (deep inspiration, closure of nose and mouth, and attempt to exhale); for decrease in intratracheal air pressure the experiment of Müller is employed (complete exhalation, closure of nose and mouth and attempt to inhale). The striking changes in the width of the tracheal lumen under the influence of these two experiments are easily explained by the decreased power of resistance of the tracheal wall in the area of malacia. In increased intratracheal air pressure this diminished power of resistance will cause an abnormal protrusion; in decreased intratracheal air pressure it will cause narrowing of the tracheal lumen in the area of malacia or a complete collapse of the trachea due to a sucking effect.

On the other hand, the changes in shape of the tracheal stenosis in normal power of resistance of the cartilaginous rings of the trachea are very small, equal and concentric on both sides; whereas in malacia, changes in shape of the trachea usually involve one wall only. These changes are not only very marked but also unequal and eccentric.

It would be too demanding on the doctor's time, especially in large hospitals, to have to explain to every patient with a

goiter the experiments of Valsalva and Müller in examining the trachea. For orientation in roentgenoscopy it appears sufficient instead of the experiment of Valsalva to have the patient cough in order to increase the intratracheal air pressure and instead of the experiment of Müller to have him sniffle in order to decrease the intratracheal air pressure.

Before examination of the trachea for changes in width of its lumen under changed conditions of air pressure it is advisable to slowly rotate the patient during roentgenoscopy until the trachea is most clearly visible; that is, that position in which the central ray passes the longest diameter of the tracheal stenosis. In serious cases of malacia we may in this manner even see roentgenoscopically a respiratory fluttering of the tracheal wall.

The tracheoscopical examination recognizes the pathological feature of malacia of the trachea by haziness of the design and narrowing of the tracheal rings, by decrease in consistency of the mucous membrane, possibly by a respiratory fluttering of the tracheal wall. However, this tracheoscopical diagnosis of malacia of the tracheal wall will be possible only in advanced cases and often then only supposedly.

A systematic roentgenological examination of the power of resistance of the cartilaginous rings against intratracheal changes in air pressure will be very useful for indicating the kind of treatment of patients with goiter. It is superfluous to state that the evidence of a pronounced malacia represents a strict indication for operation. But also evidence of a merely diminished power of resistance of the cartilaginous rings of the trachea will make an operation advisable in cases not complicated by serious pathological conditions of heart and lungs.

It is important to *know of the presence of a tracheal malacia before an operation because of danger of an asphyctic insult* during or shortly after the operative intervention. Such a serious event may require an im-

mediate tracheotomy. It is hardly necessary to mention to what extent the tracheotomy may hinder the healing of the wound. Therefore the operation in proved malacia must be performed under special precautions (a possible introduction of a tracheoscope) and according to definite methods (leaving of a coat of goiter tissue as a support around the area of tracheal malacia or fixation of the trachea by stitches) in order to avoid these untoward and extraordinarily dangerous incidents.

A malacia of the cartilaginous tracheal rings does not disappear after a goiter operation. This fact I was able to show by re-examining patients with malacia of the trachea several years after the operation. All these patients had no trouble at all after the goiter which had tightened the trachea had been removed. Stenosis of the tracheal lumen in malacia of the trachea disappears in the course of several months after the operation. Repeatedly instead of a former stenosis in the area of malacia a considerable dilatation of the trachea developed and persisted as evidenced by check examination later.

A roentgen examination of the trachea in patients with goiter reveals the type of its displacements, deviations and stenoses, and also the power of resistance of its wall. It also demonstrates the direction from which the goiter exerts the pressure. All these revelations are of great importance in a possible operation. The knowledge of the kind of pathological change of the trachea will possibly keep the surgeon from removing a lobe of a goiter, imposing by its size but not compressing the trachea and from leaving a small lobe which is the real cause of the stenosis.

The examination of the power of resistance of the cartilaginous tracheal rings in intratracheal changes of air pressure will prove its value for the indication of an operative or conservative treatment in those complicated cases of intrathoracic goiter attached by adhesions to the neighboring tissues and causing a stenosis of the trachea. This attachment to the adjacent



FIG. 1. Patient M. U. *A*, examination of goiter made with normal intratracheal air pressure (anteroposterior position). *B*, examination of same patient with increased intratracheal air pressure (experiment of Valsalva). The tracheal stenosis is considerably widened. *C*, examination with decreased intratracheal air pressure (experiment of Müller). The tracheal stenosis is considerably narrowed. Result: The power of resistance of the tracheal wall is diminished.

tissues can easily be shown roentgenoscopically by its immobility in swallowing and coughing. These are the cases which, if complicated by serious pathological changes of the heart, offer great difficulties for the determination as to whether an operative or conservative treatment is indicated.

In these difficult cases the knowledge of the quality of the power of resistance of the tracheal wall derived from the examination of the trachea under increased and decreased air pressure will facilitate the grave decision for the kind of treatment to be followed. The evidence of a weakened power of resistance of the tracheal wall, particularly in its intrathoracic part, will make an operation, though it may be dangerous, more advisable for the patient than a conservative treatment. It is superfluous to mention that the result also of the internal examination must be most carefully considered.

The roentgenograms reproduced show 2 cases of malacia of the trachea.

Figure 1 *A*, *B*, and *C* are of a patient, M. U., female, aged fifty-eight who suffered from a goiter for fifteen years, which caused difficult breathing in the last few months.

Figure 1*A*, the anteroposterior roentgenogram, shows a compression of the trachea from the right and left sides and its moderate displacement to the left (normal intratracheal air pressure).

Figure 1*B* is the same trachea under increased intratracheal air pressure (experiment of Valsalva). The lumen of the trachea widened in the area of the stenosis approximately three times the former width.

Figure 1*C* shows the same trachea under decreased air pressure (experiment of Müller). The lumen of the trachea is narrowed to about one-half its diameter under normal air pressure (Fig. 1*A*).

These changes in width of the tracheal lumen make it evident that the power of resistance of the wall of the cervical part of the trachea is diminished. The operation confirmed the roentgenological finding.

Figure 2*A*, *B* and *C* are the lateral roentgenograms of the trachea of a patient, I. G., female, aged sixty-five, with a *very severe*

malacia of the trachea. She suffered from a goiter for more than twenty years. In the last two years she had great difficulty in breathing. The anteroposterior roentgenogram showed no displacement of the trachea to the right or to the left. In the lateral roentgenogram (Fig. 2*A*) a marked displacement of the trachea backward was visible. At the same time the trachea was severely compressed by pressure exerted by the goiter from the front.

Figure 2*B* is the roentgenogram of the same trachea in increased intratracheal air pressure (experiment of Valsalva). Its lumen is widened very considerably, at least seven times, whereas under decreased intratracheal pressure of air (Fig. 2*C*) (experiment of Müller), a complete collapse of the trachea in the area of stenosis was observed.

These great changes in width of the lumen of the trachea are characteristic of a severe malacia. This finding also was fully confirmed by operation.

Not only in patients with goiter but also in a great number of other pathological conditions, displacements and stenoses of

the trachea are observed. In some of them, especially mediastinal tumors, a malacia of the trachea may occur simultaneously.

SUMMARY

It is the purpose of the roentgen examination of the trachea, after establishment of type and extent of possible displacement and stenosis, to examine the power of resistance of the cartilaginous tracheal rings. In recent goiters of young people and in goiters of adults which have existed for many years as well as in malignant goiters and mediastinal tumors, not infrequently a softening and partial disappearance of the cartilaginous rings of the trachea takes place. This fact means a great danger for the patient and may cause sudden death by collapse of the trachea. Therefore so-called malacia of the trachea is an absolute indication for operation on the goiter.

It is important to know about tracheal malacia before operation because of the



FIG. 2. Patient I. G. *A*, examination of goiter made with normal intratracheal air pressure (lateral position). *B*, examination of same patient with increased intratracheal air pressure (experiment of Valsalva). The tracheal stenosis is widened at least seven times. *C*, examination with decreased intratracheal air pressure (experiment of Müller). Complete collapse of the trachea in the area of the stenosis. Result: Severe malacia of the trachea.

danger of an asphyctic insult during or shortly after the operative intervention. Therefore the operation in proved malacia must be performed under special precautions, and the operative intervention must be modified according to definite methods. The roentgen examination of the trachea can prove without difficulty whether or not the cartilaginous tissue of the trachea is of normal resistance.

The following method of roentgen examination of the trachea in suspicious cases is recommended:

1. Examination of the trachea in anteroposterior and lateral positions in normal intratracheal air pressure.

2. Examination of the trachea in increased intratracheal air pressure (experiment of Valsalva: deep inspiration, closure of nose and mouth and attempt to exhale).

3. Examination of the trachea in decreased intratracheal air pressure (experiment of Müller: deep expiration, closure of nose and mouth and attempt to inhale).

If malacia of the trachea is present, there occurs in examination with increased intratracheal air pressure (experiment of Valsalva) a very marked dilatation of the tra-

cheal stenosis in the area of malacia, and in examination with decreased intratracheal air pressure (experiment of Müller) a very marked narrowing or complete collapse of the stenosis in the area of malacia.

Before *roentgen treatment* of a goiter or of a mediastinal tumor it is important to determine, besides the degree of stenosis of the trachea, the power of resistance of its wall. If a malacia of the tracheal wall is found, roentgen treatment must be performed with greatest care and precaution. Only very small doses on many consecutive days should be applied; otherwise a sudden swelling of the pathological tissue due to an early reaction may cause a complete collapse of the weakened tracheal wall and sudden death by suffocation.

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REFERENCES

1. SGALITZER, M., STÖHR, W. Zur Röntgenuntersuchung der Luftröhre, unter besonderer Berücksichtigung der Tracheomalazie. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1924, 32, 247-259.
2. SGALITZER, M. Die Röntgenuntersuchung bei Luftröhrenerkrankungen. *Röntgenpraxis*, 1930, 2, 636-646.



A NEW MEDIUM FOR CYSTOURETHROGRAPHY*

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FOR a period of ten years we have been using cystourethrography as an aid in the diagnosis of lesions of the bladder, prostate, and urethra. This work has been done at the suggestion of and with the closest cooperation of Dr. R. M. LeComte, urologist to Georgetown University Hospital. Extensive articles by Flocks,² Crabtree and Brodney,¹ and others, have appeared in the urological literature. The only article dealing with this subject in the past ten years in radiological journals has been the recent one by Pereira³ in this JOURNAL.

The medium which we first employed, that introduced by Flocks, was lipiodol and mucilage of acacia. Its disadvantage was that it was unstable and had to be made up freshly each time it was used. The next medium tried was skiodan in mucilage of acacia, manufactured by the Winthrop Chemical Company. This proved satisfactory, although the viscosity was not great enough. Since 1939 we have used a medium called Visco-rayopake, a product of Hoffmann-LaRoche Company. This is an aqueous solution with approximately 50 per cent organic iodine compound and 3 per cent polyvinyl alcohol. It fulfills all the necessary requirement of a good contrast medium for cystourethrography: namely, maximum opacity, minimum irritation, homogeneous nature, suitable viscosity, and it is not necessary to remove the dye from the bladder and urethra after instillation, as it is miscible with urine. This preparation has been used in all types of cases, including traumatic rupture of the urethra, and there have been no unusual reactions.

The following is a brief description of

the technique employed. The only equipment necessary is a 30 cc. syringe with 5 cm. of soft rubber catheter firmly attached to the tip as an adapter.

A plain roentgenogram of the abdomen is taken first. The bladder is emptied of urine. The patient is placed in the right anterior oblique position; i.e., with the left hip slightly elevated by use of a sandbag under the left hip. The right thigh is flexed and the left extended. The tube is centered directly over the symphysis pubis and a technique making use of the Potter-Bucky diaphragm is employed. The operator then inserts the soft rubber catheter adapter into the urethra with the right hand, forcibly extends the penis with the left hand, and at the same time exerts considerable pressure about the adapter to prevent the dye from regurgitating. Twenty cubic centimeters of the dye is slowly but steadily injected, the operator's hands protected with $\frac{1}{8}$ inch of lead plate and the first exposure of a stereo pair is made. It is important to keep constant pressure on the plunger of the syringe at all times. While the plate is being changed the remaining 10 cc. is injected and the second exposure made. The anteroposterior roentgenogram is made by immediately placing the patient in the supine position and continuing the pressure on the plunger of the syringe. It is not necessary to mechanically remove the dye (Fig. 1).

DIAGNOSIS

Adenoma of the Prostate. Adenoma of the middle lobe or middle bar enlargement displaces the bladder anteriorly with angulation of the prostatic urethra as seen in the oblique view (Fig. 2). Adenoma of the

* Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24-29, 1944.

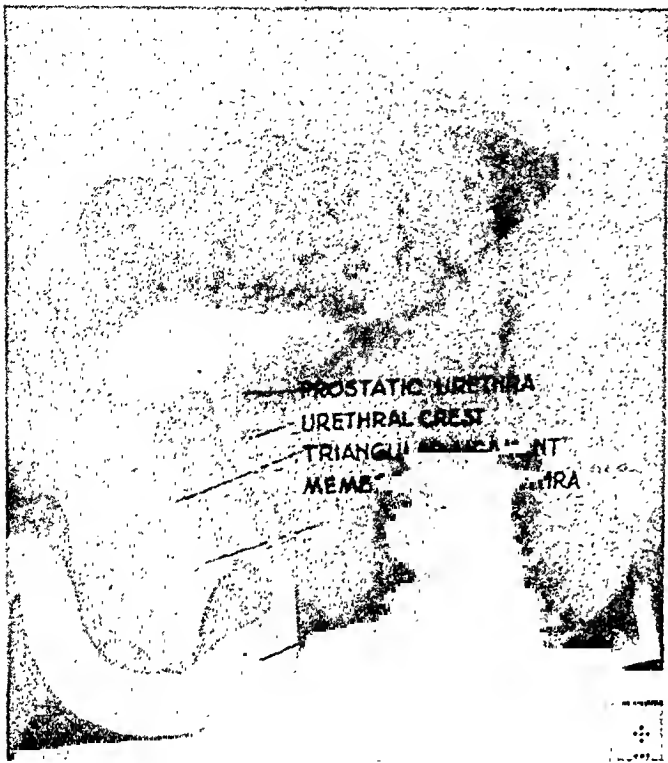


FIG. 1. Normal cystourethrogram, oblique projection. The urethra leaves the bladder at right angles. The prostatic urethra is about 25-40 mm. long and 8-10 mm. in diameter. On the posterior wall arises the urethral crest or verumontanum. The membranous portion is 12 mm. long and 4-5 mm. in diameter. The spongy urethra is about 15 cm. in length and 15 mm. in diameter.



FIG. 2. Oblique projection. There is marked intra-urethral and intravesicular spreading with lateral lobe projection into the bladder. The internal sphincter is dilated. The urethra is elongated. Lateral lobe enlargement.



FIG. 3. Cystourethrogram, oblique projection, showing adenoma of median and lateral lobes of pros-

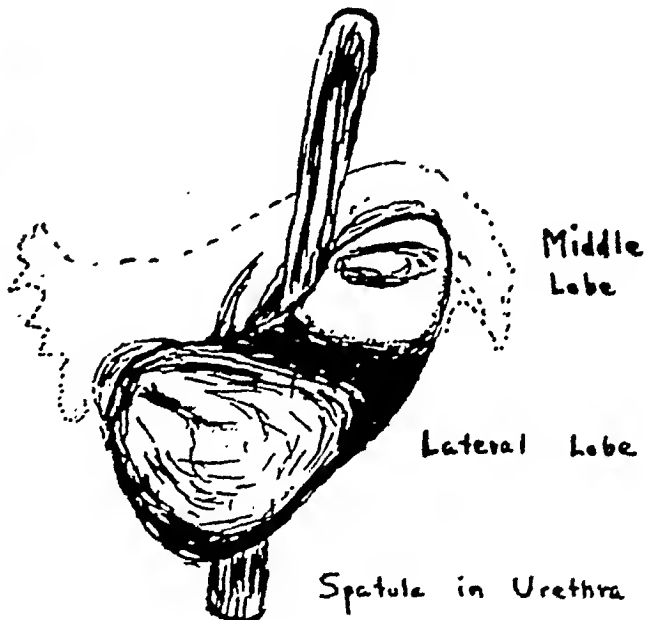


FIG. 4. Prostate after removal, showing the adenoma involving all the lobes. Outline of bladder in dotted lines as seen in Figure 3.

tate. The median lobe of the prostate protrudes into the bladder without producing angulation. The widening of the prostatic urethra is due to pressure of the lateral lobes.



FIG. 5. Urethral strictures. There is one sharp constriction in the cavernous portion about 6 cm. distal to the bulbus urethra. Additional constrictions of the bulbus urethra. The verumontanum visualizes well. Bladder elevated and prostatic urethra elongated.



FIG. 6. Cystourethrogram showing large tumor involving the right side of the bladder.



FIG. 7. Cystogram after partial withdrawal of contrast medium and injection of air, showing large tumor as in Figure 6.

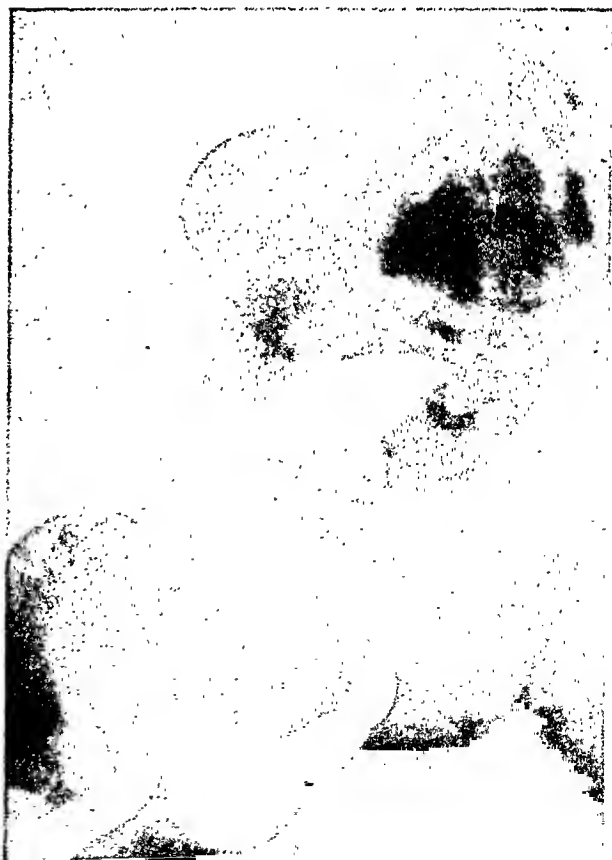


FIG. 8. Cystourethrogram, oblique projection, with elevation of base of bladder due to enlargement of the prostate. There is a large diverticulum of the spongy urethra.



FIG. 9. Anteroposterior view of same case as Figure 8 showing lateral projection of diverticulum of urethra.



FIG. 10. Oblique projection, postoperative. Irregularity of proximal spongy, membranous and

prostatic urethra, demonstrated in the oblique view by widening of the prostatic urethra in the anteroposterior dimension, and by marked lateral constriction of the column when seen in the anteroposterior view. Enlargement of one lateral lobe displaces the prostatic urethra to the opposite side as seen in the anteroposterior view. Enlargement of all lobes elevates the entire bladder, with constriction and anterior dis-



FIG. 11. Oblique projection. Funnel-shaped vesico-urethral junction after suprapubic prostatectomy. Membranous and spongy urethra normal.

placement of the prostatic urethra (Fig. 3, 4 and 5).

Carcinoma and Other Tumors of the Bladder (Fig. 6). The location, extent, and sometimes the complications of tumor of the bladder can be better demonstrated by cystourethrography than by the usual cystograms, and, in conjunction with cystograms and intravenous pyelograms, completes the roentgenological examination of the bladder.

prostatic urethra due to instrumentation plus infection. Note funnel-shaped bladder outlet.

The opaque medium is more opaque and more viscid than the iodide solution used in cystograms, and these properties, along with the oblique and anteroposterior method of examination, frequently add needed diagnostic criteria (Fig. 7).

Pathological Conditions of the Urethra. Urethritis is shown by narrowing of the spongy urethra. Strictures are easily seen by this method, showing their location and extent.

Fistulas are demonstrated with or without added injection of the external sinus.

Abscesses of the prostate with fistulous openings into the urethra are seen as irregular saccules with narrow openings into the prostatic urethra. In our series no new growths of the urethra have been demonstrated. One diverticulum of the spongy urethra was easily demonstrated (Fig. 8 and 9).

Other Pathological Findings. Cystourethrograms before and after operations on

the prostate give information on the effectiveness of the operation, and at times demonstrate the cause of unsatisfactory results (Fig. 10 and 11).

Cystourethrography when carefully executed and properly interpreted has added so much to the diagnosis and appraisal of methods of treatment that there is a growing demand for its use.

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REFERENCES

1. CRABTREE, E. G., and BRODNEY, M. L. Estimation of value of urethrogram and cystogram in diagnosis of prostatic obstruction. *J. Urol.*, 1933, 29, 235-276.
2. FLOCKS, R. H. Roentgen visualization of posterior urethra. *J. Urol.*, 1933, 30, 711-736.
3. NICHOLSON, M. A., and FIALA, M. J. Urethrography. *J. Urol.*, 1932, 28, 461-476.
4. PEREIRA, A. Importance of roentgen examination in diagnosis of adenoma of the prostate. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 51, 600-613.



TREATMENT OF PERITENDINITIS CALCAREA OF THE SHOULDER JOINT BY ROENTGEN IRRADIATION

REPORT OF ONE HUNDRED CASES

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WHEN we review the literature, we find that the study of peritendinitis calcarea of the shoulder joint has received wide attention in recent years. The consideration of this condition has been general and includes many articles on its diagnosis and pathology. By far the greater proportion of articles have dealt with treatment, however, because there are various methods currently employed. These methods of treatment have been fully discussed. Many articles have appeared on the surgical treatment of peritendinitis. Other articles have dealt with treatment by local injection. Many studies have been presented on the use of physiotherapy and some articles have investigated the value of roentgen therapy in the treatment of peritendinitis. In a previous article we have examined and discussed the relative results of these four methods of treatment.

The study which we present here deals only with the application and the results of roentgen therapy as it is utilized in the treatment of peritendinitis of the shoulder joint. One hundred cases were treated. The conclusions derived from the study are based primarily on the examination of the large number of cases. We have included in the study also some additional data that appeared in the course of our experience with these cases. Our study of the treatment of peritendinitis calcarea extends over a period of thirteen years. The earlier findings in our study have already been published. The cases presented in this paper cover a later period from 1937 to 1945. The one hundred cases of this series were divided, for therapeutic purposes, into the following three groups: acute, subacute and

chronic. The cases were considered acute when the duration of the condition was under a month. They were classified as subacute if the condition extended over a two months' period, and whenever the condition had lasted for a period of more than two months, the cases were classified as chronic. Sixty-one per cent of the cases in this series were acute; 11 per cent were subacute and 28 per cent were chronic (see Table 1).

All the cases in the series were roentgenographed before they were given roentgen therapy. Two views of the patient were taken, one with the patient on his back, his back to the film and his arm to the side of his body in anatomical position with the palm up. The other view was taken with the patient on his back, his arm in neutral position with his forearm placed across his chest with the palm down. The tube was centered on the acromioclavicular joint, 36 in. distance; kilovoltage varied with the thickness of the part. A detail screen was used without a Potter-Bucky diaphragm.

The cases were usually given roentgen therapy, six to eight treatments. These treatments were applied anteriorly and posteriorly over a period of seven to fourteen days. They averaged 125 roentgens. The kilovoltage was determined by the thickness of the shoulder. It varied from 125-200 kv., 5-7 ma., 30-40 cm. distance, with a 10 by 15 cm. cone. When roentgen therapy was given, our average case improved within seven days. The 5 cases presented here are typical of the histories of our acute cases of peritendinitis of the shoulder joint. These cases were usually given one course of treatment. The subacute and chronic cases were generally

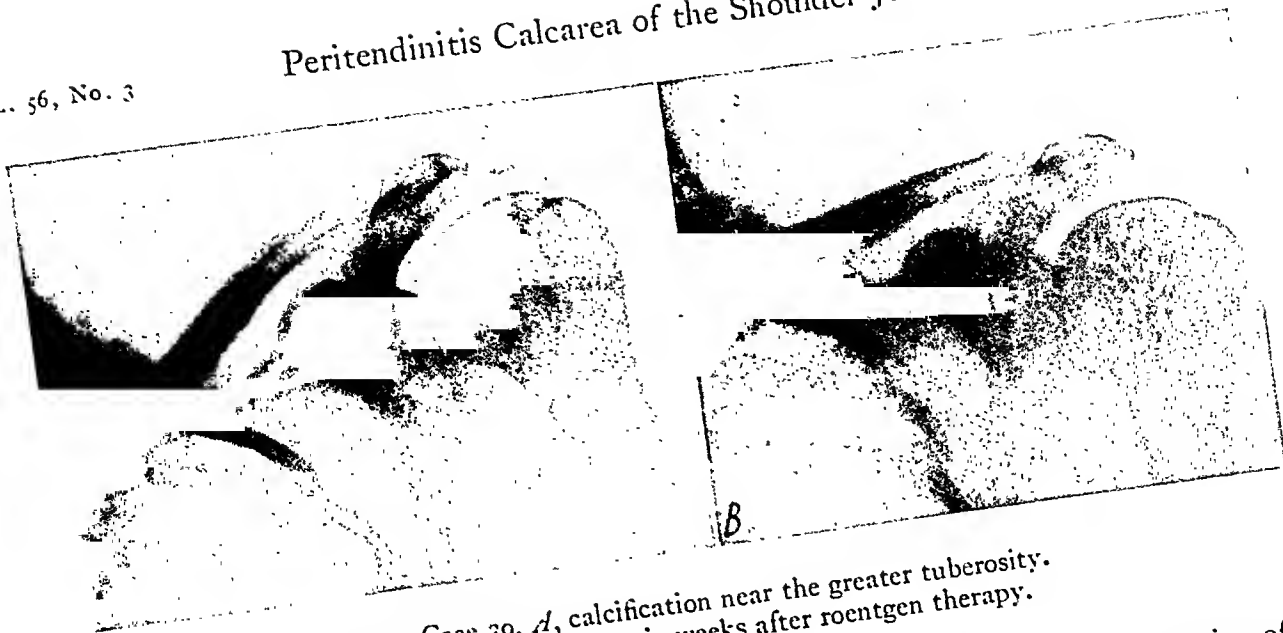


FIG. 1. Case 39. *A*, calcification near the greater tuberosity. *B*, complete resolution six weeks after roentgen therapy.

given more than one course.

The acute cases may be examined more carefully now in their case histories.

CASE 39. Mrs. T., aged thirty-six, came to our office on July 5, 1941. She complained of an acute pain in her left shoulder of one week duration. She was a seamstress by occupation and had injured her shoulder by indirect trauma. The physical examination showed evidence of local pain, tenderness and limited abduction of 15 degrees. A roentgenogram taken at the time revealed an area of calcification adjacent to the greater tubercle of the left humerus. The patient was given eight roentgen treatments. The local symptoms disappeared after four days. A second roentgenogram was taken August 19,

1941, and showed a complete resolution of the calcification (see Fig. 1).

CASE 42. Mr. F., aged twenty-six, came to our office December 16, 1941. He had injured his shoulder in reaching to close his automobile door. He complained of an acute pain in his right shoulder which had continued for five days. A physical examination showed swelling, tenderness and an abduction of 15 degrees. The patient received six treatments. After two days he had relief from pain. At the end of twelve days, he had complete abduction. When we compare the roentgenogram taken at the time of his first visit with a roentgenogram taken three months later, March 24, 1942, we note a residual trace of the calcification (see Fig. 2).

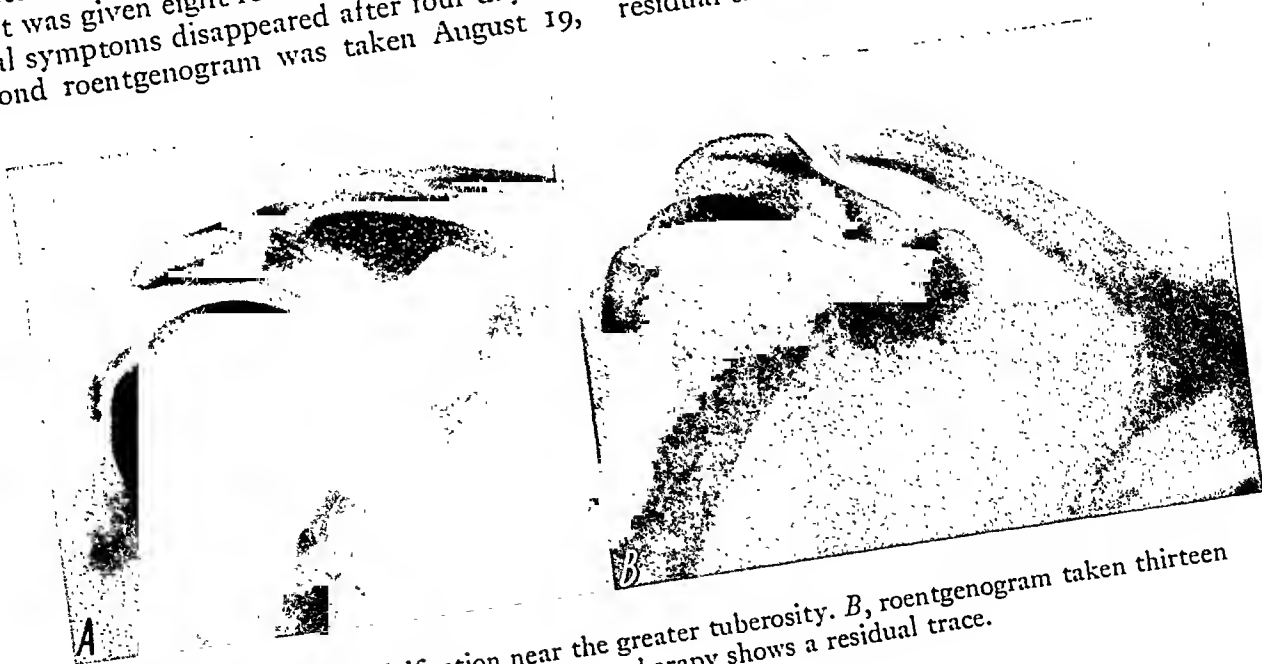


FIG. 2. Case 42. *A*, calcification near the greater tuberosity. *B*, roentgenogram taken thirteen weeks after roentgen therapy shows a residual trace.

TABLE I

No.	Name	Sex	Age yr.	Location	Type	Calcification	Disability days	Reduction
1	A.F.	M	36	Left	Acute	Yes	4	Yes
2	W.K.	M	49	Right	Chronic	None	25	None
3	S.F.	M	50	Left	Subacute	Yes	30	None
4	E.G.	F	37	Left	Subacute	Yes	10	Yes
5	M.W.	M	38	Right	Acute	Yes	10	Yes
6	W.P.	M	43	Left	Subacute	Yes	21	None
7	C.M.	F	35	Left	Acute	Yes	14	Yes
8	G.S.	M	34	Right	Acute	Yes	7	Yes
9	M.L.	M	51	Right	Acute	Yes	14	Yes
10	L.G.	M	36	Left	Acute	Yes	11	Yes
11	D.L.	F	44	Right	Acute	Yes	16	Yes
12	G.P.	M	58	Right	Subacute	None	12	Yes
13	J.P.	M	62	Right	Acute	Yes	8	Yes
14	J.L.	M	36	Right	Acute	Yes	8	Yes
15	J.L.	M	49	Left	Acute	None	3	None
16	E.L.	F	31	Right	Chronic	Yes	8	Yes
17	A.B.	M	51	Right	Acute	Yes	4	Yes
18	M.S.	M	37	Left	Acute	Yes	3	Yes
19	E.P.	M	67	Left	Chronic	Yes	7	Yes
20	L.B.	M	37	Right	Acute	Yes	13	Yes
21	R.P.	F	35	Right	Acute	Yes	10	Yes
22	J.A.	M	40	Right	Acute	Yes	11	Yes
23	E.M.	F	45	Left	Acute	Yes	7	Yes
24	I.L.	M	39	Left	Acute	Yes	15	Yes
25	C.M.	F	36	Right	Acute	Yes	3	Yes
26	E.G.	F	40	Right	Acute	Yes	10	Yes
27	L.R.	F	54	Left	Subacute	Yes	12	Yes
28	M.W.	M	61	Right	Chronic	Yes	14	Yes
29	W.L.	M	35	Right	Acute	Yes	5	Yes
30	M.S.	M	39	Right	Acute	Yes	7	Yes
31	D.T.	M	45	Right	Chronic	Yes	30	Yes
32	M.H.	F	36	Right	Acute	Yes	5	Yes
33	L.H.	M	40	Right	Acute	Yes	8	Yes
34	W.L.	M	35	Left	Acute	Yes	4	Yes
35	A.N.	F	51	Right	Subacute	Yes	13	None
36	J.F.	M	35	Left	Acute	Yes	17	Yes
37	M.S.	M	43	Left	Acute	Yes	3	None
38	R.W.	M	48	Left	Acute	Yes	5	Yes
39	A.T.	F	46	Left	Acute	Yes	4	Yes
40	F.S.	M	42	Left	Acute	Yes	10	Yes
41	J.H.	M	42	Left	Acute	Yes	3	None
42	J.F.	M	26	Right	Acute	Yes	12	Yes
43	E.V.	F	49	Right	Chronic	Yes	20	Yes
44	J.F.	M	45	Left	Acute	Yes	2	Yes
45	B.B.	M	35	Right	Chronic	Yes	9	Opera'n
46	N.A.	M	35	Left	Acute	Yes	26	Yes
47	S.G.	F	41	Right	Subacute	Yes	75	None
48	M.T.	F	46	Right	Chronic	Yes	30	None
49	R.K.	F	53	Right	Chronic	Yes	30	Yes
50	E.R.	F	44	Right	Chronic	Yes	4	Yes
51	P.T.	M	27	Left	Acute	Yes	9	Yes
52	E.B.	F	57	Left	Acute	Yes	105	Yes
53	S.H.	F	39	Right	Subacute	Yes	11	Yes
54	R.B.	F	41	Left	Acute	Yes		

TABLE I (Continued)

No.	Name	Sex	Age yr.	Location	Type	Calcification	Disability days	Reduction
55	J.R.	M	54	Right	Chronic	Yes	55	None
56	A.W.	F	55	Right	Chronic	Yes	91	Yes
57	M.B.	F	29	Right	Acute	Yes	3	Yes
58	P.H.	F	48	Right	Acute	Yes	13	Yes
59	H.L.	M	44	Right	Acute	Yes	5	Yes
60	K.B.	M	37	Left	Subacute	None	30	
61	A.S.	F	58	Right	Acute	Yes	16	Yes
62	P.O.	M	50	Left	Chronic	None	17	
63	B.D.	M	48	Left	Chronic	Yes	52	Yes
64	I.R.	F	48	Right	Acute	Yes	2	Yes
65	A.R.	F	48	Left	Acute	Yes	4	Yes
66	V.M.	F	48	Left	Acute	Yes	2	Yes
67	M.S.	M	45	Left	Acute	Yes	7	Yes
68	F.B.	M	41	Left	Chronic	Yes	75	None
69	F.L.	F	52	Left	Chronic	Yes	75	None
70	I.R.	M	41	Right	Chronic	Yes		Opera'n
71	R.S.	M	55	Right	Acute	Yes	4	Yes
72	B.G.	F	56	Left	Chronic	None	4	
73	J.H.	M	51	Left	Chronic	Yes	90	Yes
74	W.I.	M	29	Right	Chronic	None	30	
75	S.U.	F	43	Left	Acute	Yes	9	Yes
76	M.E.	M	45	Left	Chronic	Yes		Opera'n
77	A.G.	F	39	Left	Acute	None	10	
78	A.A.	F	27	Left	Acute	Yes	6	Yes
79	M.Z.	F	60	Left	Subacute	None	3	
80	J.M.	M	38	Right	Acute	Yes	12	Yes
81	A.A.	M	43	Right	Chronic	Yes	30	None
82	M.M.	F	41	Right	Chronic	Yes	60	None
83	W.H.	M	34	Left	Chronic	None	60	
84	C.W.	M	55	Right	Chronic	Yes	45	None
85	N.S.	M	55	Right	Chronic	None	19	
86	A.Z.	F	57	Left	Subacute	Yes	30	Yes
87	J.H.	M	42	Left	Acute	Yes	7	Yes
88	A.H.	F	55	Right	Acute	Yes	2	Yes
89	H.M.	M	53	Left	Acute	Yes	6	Yes
90	M.F.	F	60	Left	Acute	Yes	14	Yes
91	C.M.	F	37	Left	Acute	Yes	3	Yes
92	M.M.	F	41	Right	Chronic	Yes	38	None
93	B.W.	F	40	Right	Acute	Yes	55	Yes
94	F.P.	M	62	Left	Acute	Yes	2	Yes
95	C.L.	F	38	Left	Acute	Yes	19	Yes
96	C.S.	F	52	Right	Acute	Yes	4	Yes
97	N.A.	M	43	Left	Acute	Yes	3	Yes
98	R.W.	F	29	Right	Acute	None	3	
99	H.K.	M	55	Left	Acute	Yes	2	Yes
100	C.L.	F	38	Right	Acute	Yes	19	None

CASE 58. Mrs. H., aged forty-eight, came to our office September 17, 1942. On August 21 she had sprained her right shoulder. She had been treated from the time of the injury, until she came to our office, with physiotherapy which had not alleviated the condition. A physical

examination showed pain, tenderness in her shoulder and a limited abduction of 25 degrees. A roentgenogram revealed an area of calcification in the right shoulder. She was given six roentgen treatments. Her symptoms disappeared after six days and her arm was freely



FIG. 3. Case 58. *A*, calcification near the greater tuberosity. *B*, final roentgenogram taken nineteen weeks after roentgen therapy shows a residual trace.

movable after thirteen days. A roentgenogram taken February 8, 1943, showed a residual trace of calcification (see Fig. 3).

CASE 94. Dr. P., aged sixty-two, came to our office September 6, 1944. He had suffered pain in his left shoulder for about two weeks. Ten days previous to the visit to our office, he had received a local injection treatment which had not improved the condition. A physical examination showed that he had pain and tenderness in his shoulder and an abduction of 15 degrees. The patient received eight roentgen treatments. After two days he had relief from pain and good

abduction. A comparison between an roentgenogram taken at the time of his first visit and one taken a month later, October 26, 1944, showed a residual trace in the area of calcification (see Fig. 4).

CASE 15. Dr. L., aged forty-nine, came to our office July 13, 1939. He had complained of pain in his left shoulder for ten days. He had been given physiotherapy for six days. It had not alleviated his condition. A physical examination showed a marked tenderness and a limited abduction of 15 degrees. A roentgenogram did not show any calcification. The patient was given



FIG. 4. Case 94. *A*, calcification near the greater tuberosity. *B*, roentgenogram taken six weeks after roentgen therapy shows a residual trace.

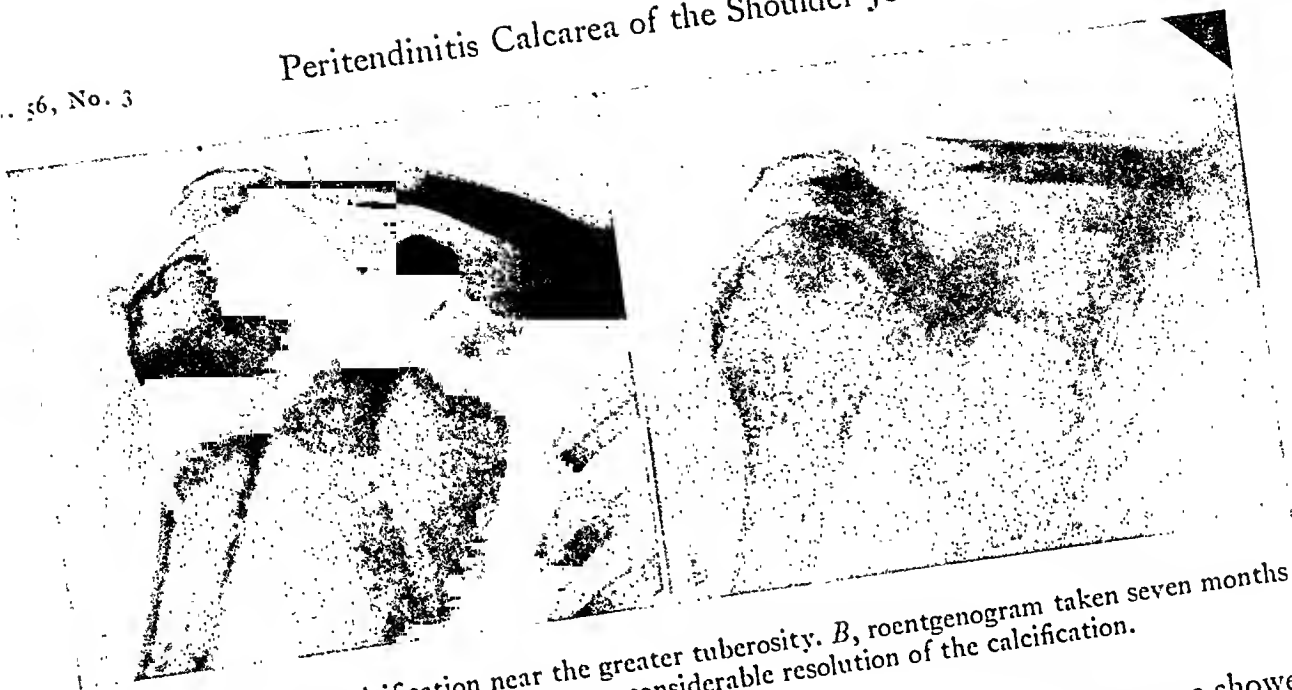


FIG. 5. Case 53. *A*, calcification near the greater tuberosity. *B*, roentgenogram taken seven months after roentgen therapy shows considerable resolution of the calcification.

three roentgen treatments. He had complete relief and good abduction in seventy-six hours.

It is important to note here that some acute cases, such as the last case presented above, in which no calcification can be seen in the roentgenogram may have some calcification microscopically.

McLaughlin* has pointed out that "... collections of tendon debris showing no opaque shadow by x-ray have been countered not infrequently in the course of shoulder operations done for other conditions." These cases respond well to therapy.

In those cases where the calcification can be clearly seen in the roentgenogram, it can be demonstrated that the deposits tend to disappear after roentgen therapy. A tabulation of the acute cases shows a partial to complete resolution of the calcification in 69 per cent of the cases of peritendinitis of the shoulder joint after treatment. The results of roentgen therapy in acute cases of this condition are excellent in relief of all the physical symptoms associated with it. The subacute cases, however, differ somewhat in their response to roentgen therapy. The disability period is longer, lasting an average of twenty-six days. These cases usually require two courses of treatment.

Thirty-six per cent of these cases showed a reduction in the calcification after treatment. Eleven per cent of the cases presented in this paper were of the subacute type. The 2 cases, which we describe, are typical of the subacute cases.

CASE 53. Miss H., aged thirty-nine, came to our office June 10, 1942. She complained of pain in her right shoulder. She had had some discomfort for a year but the symptoms had become more acute in the last six weeks. During this time she had been treated with physiotherapy but the acute pain and limitation of motion had not been ameliorated. She was roentgenographed and given two courses of roentgen therapy. She had complete relief of symptoms within three months. A roentgenogram taken April 9, 1943, shows a reduction of the calcification (see Fig. 5).

CASE 47. Mrs. G., aged forty-one, came to our office February 8, 1942. She complained of pain in her right shoulder which had continued for six weeks. There was some limitation of motion and an abduction of 85 degrees. She was roentgenographed and an area of calcification was noted in her right shoulder. She was given one course of roentgen therapy. Her symptoms disappeared after twenty-six days. A roentgenogram taken November 17, 1942, showed no change in the calcification (see Fig. 6).

These 2 cases, presented above, should be considered when we study the chronic cases

* McLaughlin, H. L. Calcific deposits in the shoulder. *New York State J. Med.*, 1944, 44, 2231-2235.



FIG. 6. Case 47. *A*, calcification near the greater tuberosity. *B*, no change in calcification.

to which they bear some resemblance. Twenty-eight per cent of the cases observed were chronic. We consider those cases chronic in which the condition continued over a period of more than two months. These cases have a disability period of thirty-six days and the response to treatment is similar to the subacute cases when they are given roentgen therapy. There was a 32 per cent reduction in the calcification in the chronic cases. The histories cited below are typical of the course of our chronic cases.

CASE 56. Mrs. W., aged fifty-five, came to our office August 20, 1942. For about eight months she had had indefinite symptoms in her right shoulder. About two months previous to her visit to our office, the symptoms had become acute. She had been treated with physiotherapy which had given her no relief. At the time of her visit to our office, she had pain and tenderness and a limited abduction of 45 degrees in her right shoulder. She was given two courses of roentgen treatment. She felt much better in twenty-five days and had a complete recovery in ninety-one days. The roentgenograms (Fig. 7), one taken on her first visit and



FIG. 7. Case 56. *A*, calcification near the greater tuberosity. *B*, roentgenogram taken one month after second course of roentgen therapy shows complete resolution of the calcification.

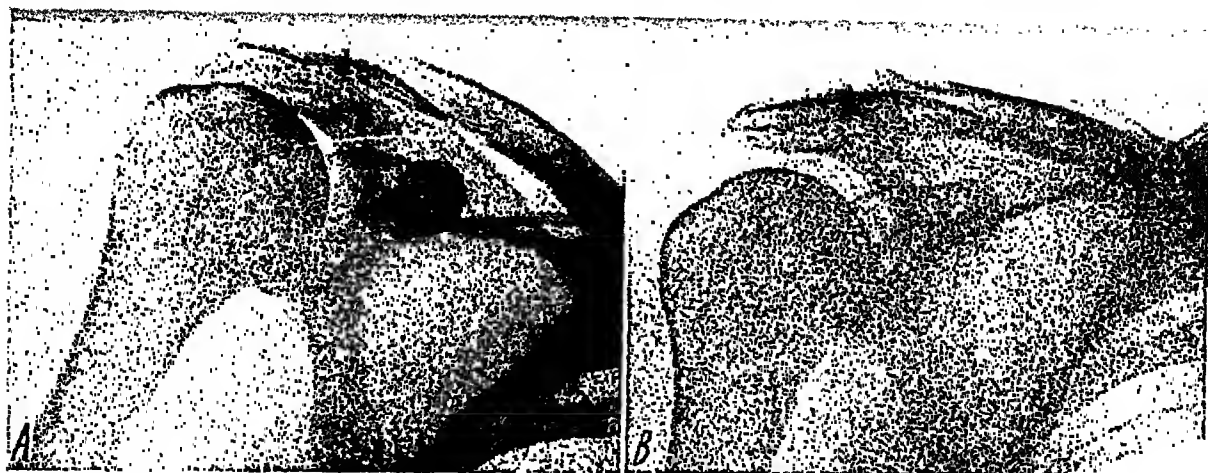


FIG. 8. Case 48. *A*, calcification near the greater tuberosity. *B*, roentgenogram taken eight weeks after roentgen therapy shows complete resolution of the calcification.

the other taken January 26, 1943, show complete resolution in the area of calcification after roentgen therapy.

CASE 48. Mrs. T., aged forty-five, came to our office February 10, 1942. She had had acute pain and tenderness in her right shoulder for over two months. A physical examination showed no limitation of motion. A roentgenogram taken at the time showed an area of some calcification. She was given two courses of roentgen treatment. She had complete relief of symptoms after seventy-five days. A roentgenogram taken April 28, 1942, showed a complete resolution of the calcification (see Fig. 8).

CASE 84. Mr. W., aged fifty-five, came to our

office January 18, 1944. He complained of pain in the left shoulder for the past four months. A physical examination showed marked tenderness and limitation of motion and an abduction of 90 degrees. A roentgenogram was taken which disclosed an area of calcification. One course of treatment was given and the symptoms disappeared completely after forty-five days. A roentgenogram taken March 11, 1944 showed no change in the calcification (see Fig. 9).

These 3 cases are typical of the usual chronic condition in our series. However, we feel that it is important to note in this article 2 chronic cases which are of excep-

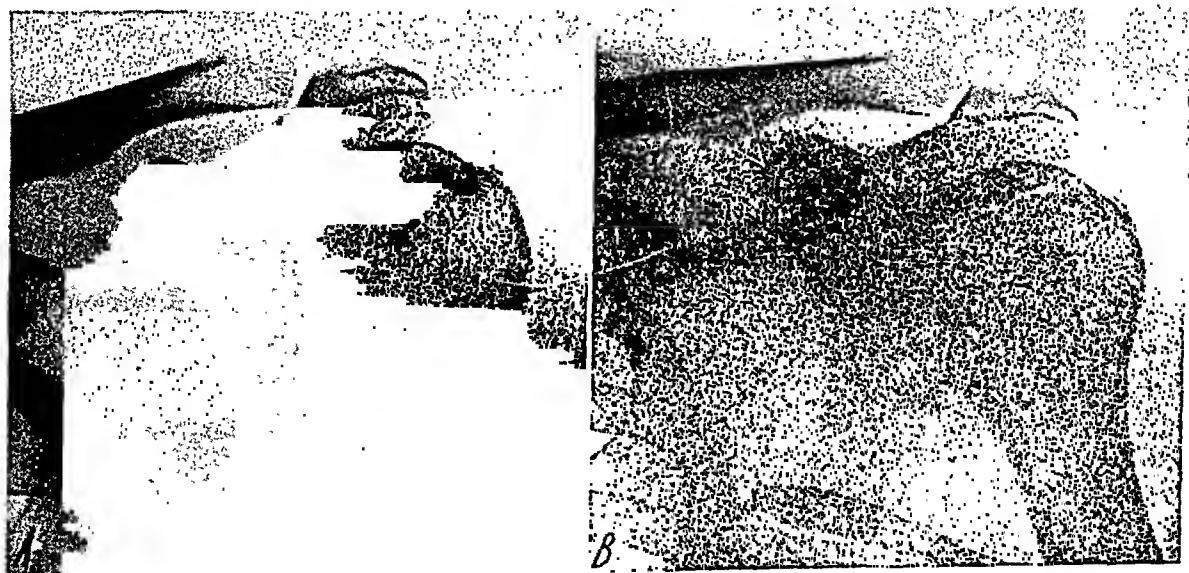


FIG. 9. Case 84. *A*, calcification near the greater tuberosity. *B*, roentgenogram taken one month after roentgen therapy shows no change in the calcification.

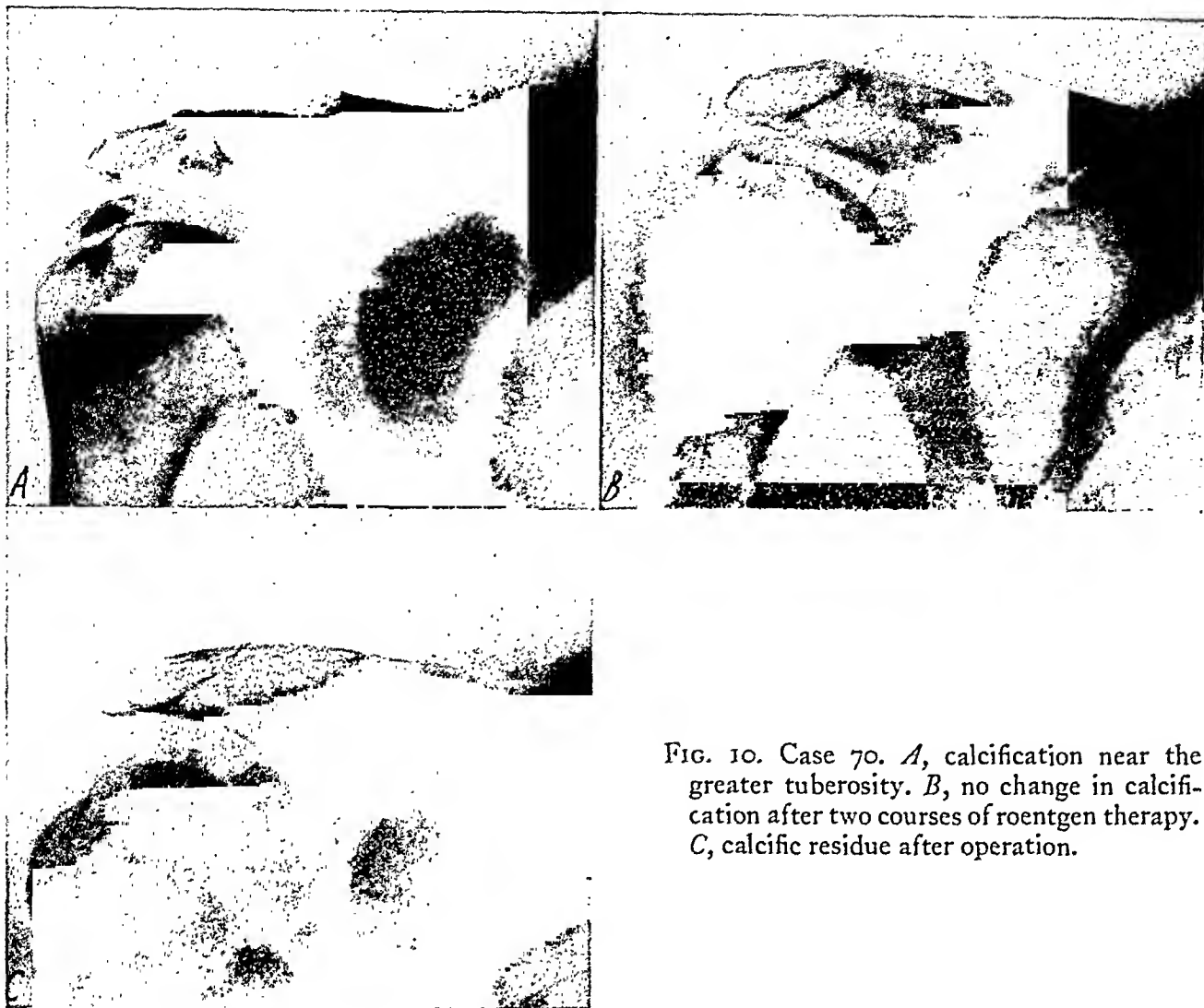


FIG. 10. Case 70. *A*, calcification near the greater tuberosity. *B*, no change in calcification after two courses of roentgen therapy. *C*, calcific residue after operation.

tional interest in the study of peritendinitis calcarea.

CASE 70. Mr. H., aged forty-one, came to our office May 8, 1943. He had been given extensive physiotherapy in 1937. When he came to us, a roentgenogram was taken which showed a large area of calcification. There was no limitation of motion noted in the physical examination. The patient was given two courses of roentgen therapy but he did not improve. We referred him to a hospital for operation. He was operated on in August, 1943. The operative report stated that "Calcification in the supraspinatus tendon was removed with curette." The patient still complained of pain in his shoulder after the operation. A roentgenogram, taken at the time he returned to the office after the operation, showed a considerable residue of calcification left in his shoulder. In view of this case, it would seem advisable to take roentgenograms at the time of operation to make certain of the complete removal of the calcification (see Fig. 10).

CASE 45. Mr. F., aged thirty-five, came to our office January 23, 1942. He had developed pain and tenderness in his right shoulder six months before his visit to the office as a result of an accident. The symptoms had persisted and he was given needling and irrigation. The condition did not improve. When he came to our office, a roentgenogram was taken which showed a large, bone-like body adjacent to the greater tubercle (Fig. 11*A*). He was given one course of roentgen therapy. It did not relieve the condition. We suggested an operation and this was performed in June, 1942. A large osteochondroma (Fig. 11*B*) imbedded in the supraspinatus tendon was removed, with good results.

It is evident that in those cases of peritendinitis in which the calcification is bone like, it is impossible to reduce it with roentgen therapy. However, where the bone formation is small, the patient may be relieved of his symptoms. Three of the cases in the series were sent for operation.

However, these chronic cases were exceptional.

Most of the 100 cases in the series followed definite patterns from which we are able to make certain deductions. These deductions relate to the value of roentgen therapy in the treatment of peritendinitis.

acute and chronic cases reacted similarly to treatment.

Those acute cases, which did not show calcification in the roentgenogram, were treated in the same manner as the other acute cases and were completely relieved.

Roentgen therapy had no effect in the

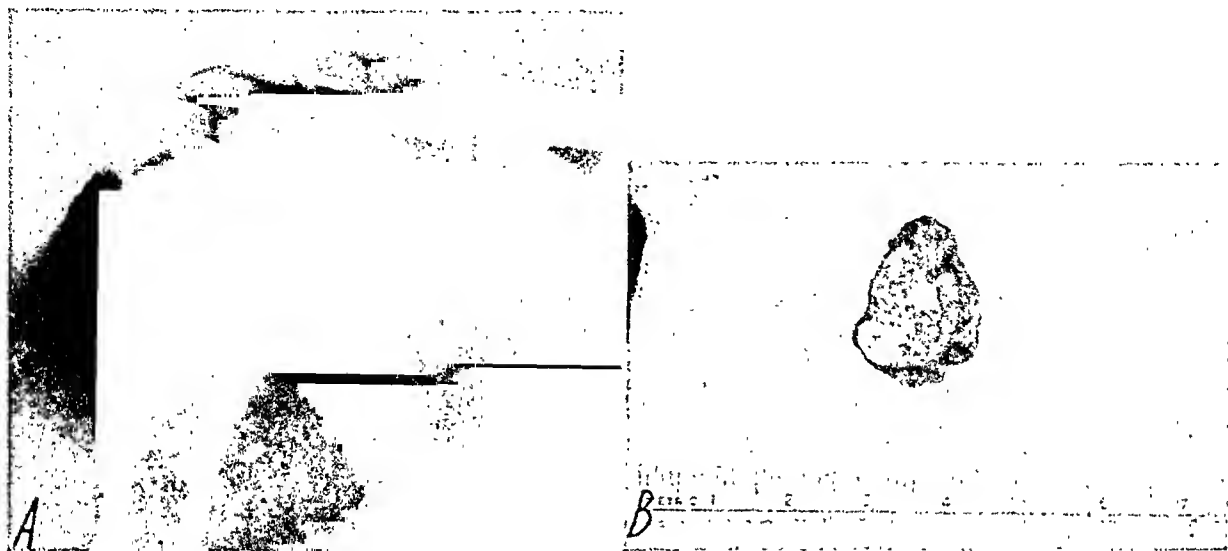


FIG. 11. Case 45. *A*, bone-like body near greater tuberosity. *B*, osteochondromatous loose body removed from shoulder.

It clarifies the use of the treatment to show how it was applied to the acute, subacute and chronic cases by dividing them into these three groups.

We have noted that of the three groups the acute cases responded the most successfully to roentgen therapy both in regard to the length of the disability period and in the reduction of the calcification.

The subacute and chronic cases responded less satisfactorily to the treatment than the acute cases. Their disability periods were generally longer but they had some reduction in the calcification. Sub-

treatment of those cases of calcification which had gone on to form bone that was sufficiently large to present a mechanical obstruction.

In conclusion, we feel that it is important to point out that the roentgen irradiation affects the acute inflammatory reaction of the condition, and therefore an effort should be made to treat cases of peritendinitis calcarea as soon as possible in order to achieve the best results.

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SIMPLIFICATION OF TISSUE DOSE ESTIMATION IN ROENTGEN THERAPY*

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THE need for determining tissue doses in roentgen therapy is generally recognized. But their estimation and recording in clinical practice, and the thinking in terms of tissue dose, are still far from being universal among radiologists. Though the therapy record form of the Radiological Society of North America, which provides columns for the recording of the daily and total surface and depth dose, is widely used, these columns are frequently left blank or still contain "grand totals" of incident doses in air or of surface doses including backscatter. One main reason for this status

vided by various laboratories. The more recent ones are in fair agreement, cover a wide range of physical factors and are generally accessible.

While the data on the dependence of the skin dose D_0 on the two determining factors, quality of radiation and area of irradiated field, can easily be presented in graphs or tables from which the percentage backscatter, or alternatively the incident dose in air D necessary for 100 r skin dose can be read off immediately for a wide variety of treatment conditions (Table I), the greater number of interconnected factors

TABLE I
ROENTGENS IN AIR PER 100 ROENTGENS ON SKIN (INCLUDING BACKSCATTER)

Half-Value Layer mm. Cu	Area in cm. ²							
	5	20	50	75	100	150	225	400
0.25	88	82	77	75	73	70	69	67
0.5	87	81	76	74	72	69	68	66
1.0	88	82	77	75	74	71	70	67
1.5	89	85	79	77	76	74	73	69
2.0	91	86	83	81	79	77	76	73

After Quimby,² Fig. 65 and 66.

is the lack of ease in the application of the available fund of dosimetric information in routine roentgen therapy.

The direct measurement of tissue doses is only possible at the surface and in a few cavities. Fundamental difficulties connected with direct measurement of tissue dose tend to render the results of clinical measurements more inaccurate than the calculation from charts based on measurements of physical laboratories. Such charts and tables have been experimentally pro-

does not allow a similar simplicity in the determination of the depth dose D_n . It requires the use of different sets of isodose charts. Routine depth dose determination is, as a rule, limited to the calculation of depth doses in the central beam from depth dose tables. Different radiation qualities require different sets of tables. A single quality requires different tables or conversion factors for different focus-skin distances. For a single case the use of one or more sets of tables becomes necessary

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whenever flexibility of treatment regarding area, radiation quality and distance is essential.

In the search for simplification of depth dose estimation for clinical purposes various workers,¹ among whom Packard² has been the proponent in this country, have attributed to the percentage depth dose in 10 cm. PD_{10} , D_{10} expressed as percentage of D_0 , a similar significance regarding dosage distribution in the irradiated tissue as has been assigned to the half-value layer in the characterization of radiation quality. They pointed out that in a similar way as the half-value layer sufficiently characterizes a radiation quality for clinical purposes, though it represents only one point of its absorption curve, the percentage depth dose in 10 cm., which informs precisely only on the radiation intensity in the depth of 10 cm., informs also with clinically sufficient exactness, within the limits of roentgen therapy, with medium qualities at least, on the intensities in other depths than 10 cm., independent of the combination of variable factors with which it is obtained.

By neglecting, for clinical purposes, the variation of percentage depth doses PD_n in central beams with identical PD_{10} , it becomes possible to prepare one table which allows one to read off immediately PD_n in dependence on PD_{10} . PD_{10} can be determined from a second table in dependence on the three main factors influencing depth dose, radiation quality, focus-skin distance and area of irradiated field. All data necessary for depth dose estimation for a continuous range of qualities and the customary combination of distance and field factors in this range can be provided by these two tables.

This simplified method of depth dose estimation stands or falls with the accuracy that it affords. The margin of error which it introduces has been determined previously^{1,2} as $\pm 2-5$ per cent. As these figures were derived from depth dose data which did not yet cover the wide range of variation of factors of more recent measurements and in part might be subjected to criticism

concerning the experimental technique, I reviewed from the same angle the most recent data, published by Quimby³ in 1944 for qualities of half-value layer 1 mm. Al-2 mm. Cu, and for harder rays of half-value layer 2-5 mm. Cu the tables published by Mayneord and Lamerton⁴ in 1941.

Comparison of sets of percentage depth doses in central beams with identical PD_{10} obtained with extremely different treatment factors reveals the maximum differences that may occur in other depths than 10 cm. and the margin of error in the case of the substitution of an average for the two different sets. In clinical practice the differences will be smaller because the more commonly used combinations yield, as a rule, depth doses between those of the extremes.

Figures 1 and 2 show examples of such comparisons graphically and in tables. Figure 1 is representative of a lower range of PD_{10} , in which the medium radiation qualities of half-value layer 1-2 mm. Cu overlap with softer radiations of half-value layer 0.25-0.5 mm. Cu, and Figure 2 of a higher range of PD_{10} , in which they overlap with harder radiations of half-value layer 3-5 mm. Cu. At both levels, as in the intermediate range, the percentage doses in depths less than 10 cm. are higher for softer than for harder rays and vice versa in greater depths. The relative influence of area and distance is less uniform. However, we are here not concerned with the analysis of the different factors influencing depth dose but with the range of differences in beams with identical PD_{10} .

The differences tend to be smaller in beams with high than with low PD_{10} up to PD_{10} 54. This point is of interest in view of the present trend to use voltages above 200 kv. However, I have not reviewed any data on beams with PD_{10} above 54.

The differences of doses in beams with identical PD_{10} below 10 increase rapidly to 20 per cent and more. PD_{10} cannot be used as a guide in depth dose estimation in superficial roentgen therapy. It has never been recommended in this field.

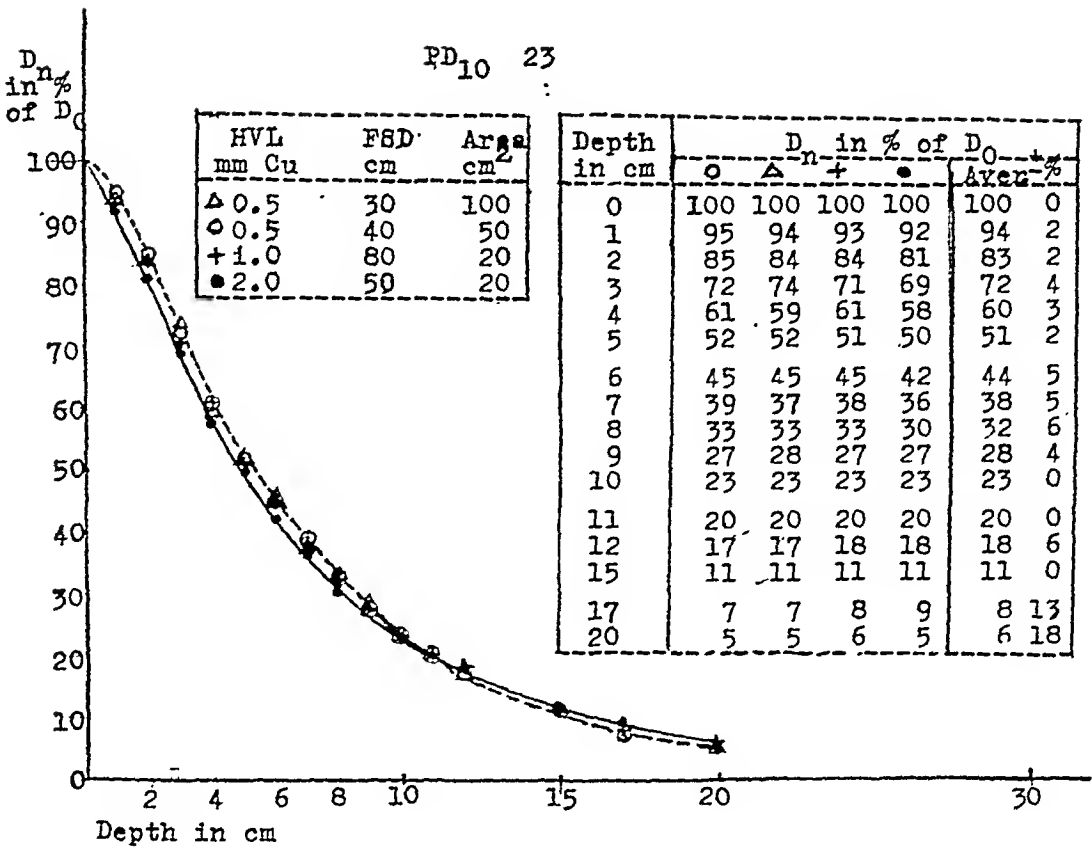


FIG. 1

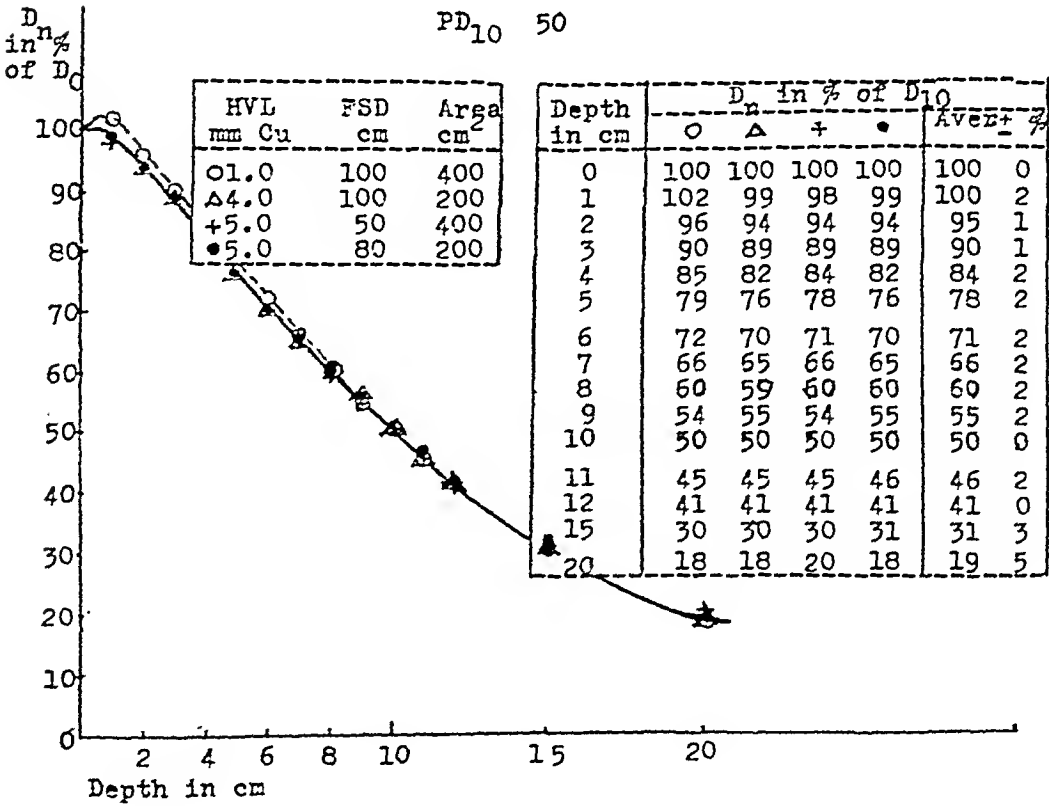


FIG. 2

For beams with PD_{10} 10-50, obtained in so-called deep roentgen therapy, I found in depths less than 10 cm. maximum differences of 12 per cent, or an error of ± 6 per cent for a substituted mean. In depths below 15 cm., where the percentage figures become very small, their variation may

in the range of 12 per cent by physical factors alone. What degree of exactness can we, in the present stage of dosimetry, reasonably expect to obtain in tissue dosage estimation? We have to concede that at its best it gives only approximations.

The differences in the data from different

TABLE II
VALUES OF PERCENTAGE BACKSCATTER
COMPARISON OF VALUES AFTER QUIMBY AND AFTER MAYNEORD

Half-Value Layer mm. Cu	Area of Field in cm. ²											
	20		50		100		150		200		400	
Author	Q	M	Q	M	Q	M	Q	M	Q	M	Q	M
0.5	24	14.6	32	25.0	39	33.0	43	37.0	47	39.7	55	43.0
1.0	22	16.7	30	26.0	37	33.9	41	38.0	44	41.0	53	45.2
1.5	18	14.3	26	22.7	32	30.5	36	34.3	39	37.1	45	42.4
2.0	15	12.6	22	20.0	28	27.4	31	31.0	34	33.3	40	37.7
3.0	11	10.0	16	16.0	22	22.5	25	25.3	28	27.5	31	31.0
4.0	9	8.0	13	13.4	18	19.0	22	21.6	23	23.5	27	26.5

TABLE III
VALUES OF PERCENTAGE DEPTH DOSE IN 10 CM.
COMPARISON OF VALUES AFTER QUIMBY AND AFTER MAYNEORD

Area cm. ²		20				50				100				400			
Half-Value Layer mm. Cu		1		2		1		2		1		2		1		2	
Author		Q	M	Q	M	Q	M	Q	M	Q	M	Q	M	Q	M	Q	M
Focus-Skin Distance	40	19	22	21	24	23	27	26	29	28	32	31	34	38	44	40	46
	50	20	22	23	25	25	28	28	30	30	33	34	36	41	45	44	48
	80	23	24	27	27	29	30	33	32	34	35	39	38	46	49	50	51

The values after Mayneord and Lamerton in Tables II and III represent mean values obtained from the literature including their own measurements.

reach ± 20 per cent. The maximum differences above 10 cm. are not found, as previously, in the first few centimeters but in greater depths.

What is the significance of an error of this magnitude for our purpose? We do not want to uncritically increase the inaccuracy of dosage which is already, according to Quimby's estimation, under best conditions

laboratories, with which we have to cope whenever we compile, compare or reproduce irradiation effects reported in the literature, are still in the same range as the variations of percentage doses in beams of equal PD_{10} (Tables II and III).

Tissue doses which are calculated in central beams and for their crossing points determine only maximum dosage in one or

several geometrically defined points within the lesion. The determination of the as or more important minimum dose in its borders remains more inaccurate even if isodose charts are being used. They are not published for the same great variety of combinations of treatment factors as tables on depth dose in the central beam. Those that are available from different sources show greater discrepancies in the periphery than in the center of the beam.

that the logarithms of percentage depth doses, if plotted against the depth, tend to fall in straight lines. His method of determining PD₁₀, however, required three steps, the use of one graph and of two nomograms. These four steps can be replaced by only two readings from Tables IV and v.

The two tables cover the factors of average deep roentgen therapy. Both are obtained from the latest depth dose tables by Quimby.³ The values of PD₁₀ in Table

TABLE IV
PERCENTAGE DEPTH DOSE IN 10 CM. FOR VARIOUS COMBINATIONS OF TREATMENT FACTORS

Focus-Skin Distance	Area cm. ²	5					20					50					75				
in cm.	Half-value layer mm. Cu	0.25	0.5	1.0	1.5	2.0	0.25	0.5	1.0	1.5	2.0	0.25	0.5	1.0	1.5	2.0	0.25	0.5	1.0	1.5	2.0
30		9	13	14	15	15	13	15	18	19	20	17	19	21	23	24	19	21	24	25	27
40		10	14	15	16	16	14	16	19	20	21	19	21	23	25	26	21	23	26	28	29
50		11	14	16	17	18	15	18	20	22	23	20	23	26	27	28	23	25	28	30	31
60		11	15	16	18	20	16	19	21	23	25	20	24	27	29	30	23	26	30	32	33
70		12	15	17	19	21	16	20	22	24	26	21	25	28	30	32	24	27	31	34	35
80		12	16	18	20	23	17	21	23	26	27	22	26	29	32	33	25	28	32	35	36
100		13	17	19	20	24	18	22	24	27	28	23	27	30	33	34	26	29	33	36	38

Focus-Skin Distance	Area cm. ²	100					150					225					400				
in cm.	Half-value layer mm. Cu	0.25	0.5	1.0	1.5	2.0	0.25	0.5	1.0	1.5	2.0	0.25	0.5	1.0	1.5	2.0	0.25	0.5	1.0	1.5	2.0
30		21	23	25	27	28	23	26	28	30	31	25	28	30	32	34	28	31	33	34	35
40		23	26	28	30	31	25	28	31	33	34	28	31	33	35	38	31	34	38	40	42
50		25	27	30	32	34	27	30	33	35	36	31	33	35	38	40	33	37	41	43	44
60		26	28	32	34	36	28	31	35	37	38	32	34	37	40	42	34	39	43	46	47
70		26	29	33	36	38	29	32	37	39	40	32	35	39	42	43	36	40	45	48	50
80		27	30	34	37	39	30	33	38	40	42	33	37	41	43	45	37	42	46	49	51
100		27	31	35	38	41	31	34	39	41	44	33	38	42	44	46	38	43	48	50	52

(Values after Quimby)

In this situation the use of PD₁₀ as guide in depth dose estimation appears justified when its limitations are kept in mind. If the results of the simplified method of estimation are regarded as a first draft, it will stimulate the better utilization of more accurate data in selected cases rather than eliminate it.

Packard presented a simple graphical method of determination of PD_n in dependence on PD₁₀, based upon the finding

IV are taken either directly from individual tables for tabulated combinations of physical factors or, for combinations not covered by the tables, from curves obtained from their data. Table v is prepared from the same tables by substituting mean values for different sets of percentage depth dose values of beams with identical PD₁₀ obtained by various combinations of physical factors as shown in the examples in Figures 1 and 2.

The first reading, from Table iv, furnishes PD_{10} for any combination of physical factors, the second reading, from Table v, PD_n in the depth of n cm. The finding of PD_n in the right column of Table v is facilitated by the superscription of the values of PD_{10} .

The final step of calculating the actual depth dose D_n in n cm. depth in tissue roentgens is a multiplication which becomes extremely simple if the dosage pre-

different techniques but also in dealing with slight changes becoming frequently necessary in a course of treatments.

As an example, let us consider the following case, illustrating a rather common situation. A lesion in 5 cm. depth has been treated with the following combination of factors: half-value layer 1.0 mm. Cu, focus-skin distance 50 cm., area of field 10×10 cm.² and a daily surface dose D_0 of 300 r. The daily depth dose D_5 was 180 r. It is

TABLE V

DEPTH DOSES IN PERCENTAGE OF SURFACE DOSE FOR PERCENTAGE DEPTH DOSES IN 10 CM. 10-50

Depth cm.	Percentage Depth Dose in 10 cm.																				
	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1	77	84	87	88	90	92	93	94	95	97	98	99	99	100	100	101	101	101	102	103	104
2	61	69	73	75	78	81	83	84	86	89	90	91	92	93	93	95	97	99	100	100	100
3	48	56	61	62	65	68	70	72	74	78	80	81	82	83	84	87	88	89	92	92	93
4	37	44	48	49	53	57	60	61	64	68	70	72	74	75	76	78	80	82	85	86	87
5	29	35	38	41	44	47	50	52	55	58	60	63	65	67	68	71	72	74	77	78	79
6	24	26	30	33	37	40	43	45	47	51	53	55	57	59	61	62	64	66	69	70	72
7	19	21	23	27	31	34	36	39	41	44	46	48	50	52	53	56	58	60	63	64	65
8	15	17	19	23	26	30	32	33	35	38	41	42	44	47	48	50	52	53	57	58	59
9	12	14	16	19	21	24	26	27	30	33	35	37	39	41	42	44	46	48	50	52	54
10	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
11	8	10	12	14	16	17	19	21	23	25	26	28	30	32	33	36	38	40	41	43	44
12	7	8	10	11	13	15	17	18	20	22	23	25	27	28	29	33	34	36	37	39	40
13	6	7	8	9	11	12	14	15	17	19	20	21	23	25	26	28	30	32	33	35	37
14	5	6	7	8	9	10	12	13	15	16	17	19	20	22	23	26	27	28	29	31	33
15	4	5	5	6	8	9	10	11	13	14	15	17	18	19	20	23	24	25	26	28	31
16				5	6	8	8	10	11	12	13	14	15	16	18	20	21	22	23	25	27
17				4	5	6	7	8	9	10	11	12	13	14	15	18	18	19	20	22	24
18				3	4	5	6	7	8	9	10	11	11	12	14	16	16	17	18	20	21
19				2	4	5	5	6	7	8	9	10	10	11	11	14	14	15	16	18	19
20				2	3	4	5	6	7	8	8	9	9	10	11	12	12	13	14	16	17

scription is made in round figures for the surface dose including backscatter instead, as usually preferred, for the incident dose measured in air.

Prescription in surface tissue dose by exposure time is simplified by tabulating the roentgens in air for 100 r surface dose, in the manner of Table i, and adding the exposure times necessary for each percentage dose in air with all techniques in use.

The simplification for routine estimation and recording of depth doses which Tables iv and v offer by doing away with readings from a multitude of individual tables is not only experienced in working with markedly

desirable to decrease the area of field to 4×5 cm.² without essential change in the daily depth and surface dose. Which changes of physical factors have to be made for this purpose? Table iv informs us that while PD_{10} was 30 with the old combination of factors, it is for an area of 4×5 cm.² only 28 at its best, if the half-value layer is raised to 2.0 mm. Cu and the focus-skin distance to 100 cm. Table v shows a drop from 60 to 58 in dependence on PD_{10} 30 or 28 respectively. This difference of only 2 per cent, which means a drop from 180 r to 174 r daily D_5 , is within the limits of accuracy of dosimetry. We, therefore, choose the new

combination of factors half-value layer 2.0 mm Cu, 100 cm. focus-skin distance, 4×5 cm². area and record the changed daily depth dose of 174 r.

The estimations require a minimum of time. They are made instantaneously with the change of area and without essential delay of the treatment. It is their deferment to a later time which so frequently leads to their omission.

The available data for the calculation of percentage depth doses from the incident dose in air offer a valuable and convenient short cut for checking purposes as long as the dosage prescriptions are made in roentgens measured in air. The exclusive application of this method of simplification of depth dose estimation, as outlined by Roth,⁵ however, would eliminate the indispensable information on the surface dose and support rather than eradicate the confusion regarding dosage expressions in terms of physical and of tissue dose.

Routine estimation of approximate tissue doses as percentages of the surface dose and the drafting of their distribution in the depth and on the surface is made possible in clinical practice by the ease provided by the method of taking PD₁₀ as guide and using only two tables for all purposes. While measurements and depth determinations remain the share of the physician, every technician can learn to read the two tables and record the daily doses reliably despite changes in technique.

The main points in which routine tissue dose estimation and recording have proved to be eminently helpful are: (1) the intelligent and individualizing conduct of treatments, (2) the accumulation of information, such as data on depth intensity and daily depth dose, allowing a better evaluation and correlation of radiation effect and dosage, and (3) an educational influence by detaching the thinking of the radiologist from merely physical factors and concentrating it on the biological and therapeutic part.

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REFERENCES

1. HOLTHUSEN, H., and BRAUN, R. Grundlagen und Praxis der Röntgenstrahlendosierung. Georg Thieme, Leipzig, 1933.
2. PACKARD, C. Calculation of percentage depth doses. *Radiology*, 1938, 30, 613-621.
3. QUIMBY, E. H. Tissue doses in x-ray therapy, and Appendix. In: Physical Foundations of Radiology. By E. H. Quimby, L. S. Taylor and J. L. Weatherwax. Paul B. Hoeber, New York, 1944.
4. MAYNEORD, W. V., and LAMERTON, L. F. A survey of depth dose data. *Brit. J. Radiol.*, 1941, 14, 255-264.
5. ROTH, G. E. Method of simplified depth dosage calculation for clinical purposes. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1941, 45, 915-921.

DISCUSSION

DR. EDITH H. QUIMBY, New York. Dr. Hamann has worked out an extremely ingenious and interesting method for correlating the dose at any depth within the tissues with something which is in effect a measure of the quality of the radiation, namely, the amount of radiation delivered at a depth of 10 centimeters in the phantom. She has gone one step further than Mayneord, who made such a correlation with half-value layers, including the extra statements of distance and field.

She has succeeded in reducing all depth dose data to two tables, but I must say I can't see the practical application of it as preferred to the ordinary depth dose tables which are generally employed.

Dr. Hamann has made several points in her paper which I would like to try to answer step by step.

In the first place, she says—and it is unfortunately true,—that there are a great many radiologists who at the present time are not recording tissue doses as would be to their best advantage. Since this is true, anything we do to promote such recording is greatly to be desired. I doubt whether giving them two charts whose use they would have to learn by rote would help. Methods of using standard depth dose tables are straightforward. The fact that they are on several pages instead of two is of no importance. It is not a great intellectual feat to find the proper page.

Dr. Hamann makes the point, which is an extremely important one, that at the present time we can only measure depth doses along the axis of the beam. That is true. She also makes the point that there are greater discrepancies

among various workers who have published isodose charts, among the doses at the edges of the isodoses than in the center. That is true, too, and will continue to be true until we develop some satisfactory method for measuring distribution of radiation near the edge of the beam in the phantom. That is a problem which the physicists still have to face, and it is to be hoped that some time soon it will be solved. But that is beside the point at present; Dr. Hamann's tables offer no more aid in this problem than do any others dealing only with doses along the axis of the beam.

She agrees that the method which she advocates is not applicable to superficial therapy. It is in that region that, at the present time, we have the greatest scarcity of accurate information. However, her data are applicable to the range of high voltage and supervoltage therapy. She has made up her tables from published tables for these qualities of radiation. To me this appears only as introducing an unnecessary complication into the use of the published material.

The point she makes that it is necessary to know the skin dose in order to have the best information about therapy is certainly correct. We want to know three things: We want to know the dose in air because our machines are calibrated in air and that is the way we determine the length of time to run the machine. We want to know the dose on the skin because we are limited by this dose in the amount of radiation we can administer. We want to know the dose where the tumor is, because this is actually the dose which will or will not cure.

Now this tumor may be in the skin, or it may be at any depth whatever. I'm afraid the introduction of an intermediary D-10 will, far from simplifying the matter, confuse radiologists to the point where they think D-10 is the only thing that needs recording and not bother to go any further. As a matter of fact, I have encountered that difficulty already in talking to people about tissue doses. I have asked a number of people at different times about how they determine tissue dose or what tissue dose means and some of them say, "Oh, that is the dose at ten centimeters." Of course it isn't, but if we introduce such an intermediary term, I'm afraid that we will be introducing confusion rather than taking it out.

The published tables from which Dr.

Hamann has taken her data contain on each page the dose in air, and the dose at every depth, including zero depth, which is the skin; and they are put up in two forms: on one page is the dose at various depths for 100 r in air, in which case of course the dose on the skin is greater than that by the backscatter. If, however, it is desired to start with 100 r on the skin, the other page gives all doses in relation to this. In this case of course the dose in air is lower than 100 r.

I am at a loss to find anything in these tables beyond an interesting fact that the available information on depth doses can thus be correlated,—it is interesting and may turn out to be important, but as far as its practical immediate application is concerned, my feeling is that the radiologist would be more confused by having two arbitrary tables to work with than he would be by having a dozen pages of straightforward tables of the sort to which he is beginning to become accustomed.

DR. HAMANN (closing). I am very grateful for the discussion by Dr. Quimby. Her apprehension that the presented method might cause confusion appears in my opinion unfounded, as an understanding of the interrelations of factors determining tissue doses is necessary for all depth dose estimations and should enable anyone to use the presented condensed tables as well as the individual ones.

While for a single depth dose determination the use of an individual table covering exactly the combination of treatment factors in the given case is undisputably the simplest procedure the presented method is concerned with the simplification of routine depth dose estimation and recording in the average roentgen practice, where it is very frequently omitted when the use of a great number of tables becomes necessary.

Clinically speaking, there is another factor favoring these omissions. That is the relatively great number of patients, seen in every roentgen practice, receiving palliative treatments only. In these cases, tissue dose estimation is usually regarded as not worth the effort, whereas, simplified estimation, which can be done rapidly and with a minimum of effort, furnishes not only the basis for their best management but also contributes to the accumulation of data of radiological interest.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Committee on Arrangements: To be appointed.

Twenty-ninth Annual Meeting, 1947: To be announced.

E D I T O R I A L

THE GENETIC EFFECTS OF RADIATIONS

The sterilizing power of the roentgen rays was noted soon after their discovery half a century ago. Numerous studies have been carried out since then by irradiating ova or sperm and observing the anomalous developments, particularly in relation to the change of configuration of the chromosomes. It was not, however, until 1927 that Muller¹ first found that the roentgen rays could also produce gene mutations which may lead to abnormal distribution of the hereditary material without demonstrable change in the composition of the chromosomes themselves. This at once gave such impetus to genetic investigations that a vast literature dealing with all phases of the subject grew up within a relatively short time.

Recently an excellent series of articles on experimental and applied radiobiology have been published in the *British Medical Bulletin*. Several of the authors discuss the genetic effects of the roentgen rays and other radiations, giving a very comprehensive summary of the present state of research in this field.

Spear,² after reviewing some of the most important contributions states that it is now generally realized that the alterations in the chromosomes are of at least two kinds: (1) changes in the linear arrangement of the chromosome threads, resulting from single or double breakage; and (2) changes in the composition of the genes or unit hereditary particles, without disturbance of their position on the chromosome thread (gene mutation). The first are important from the point of view of study of the immediate effect of the radiation. Inas-

much as the injury is irreversible it is possible to evaluate the hits of the particular radiation used fairly accurately. The second kind of changes may not exert an effect for several generations, causing infertility in the later offspring.

Insects and plants furnish the most suitable material for genetic investigations since they have a small number of chromosomes of large size. According to Spear an added advantage is the fact that no matter at what point in the life cycle of the cells the irradiation is undertaken, the changes are best recognized in the metaphase and anaphase of the division. Exception is made for some of the cells irradiated in the very early mitotic stage which may disintegrate in the late prophase or early metaphase and thus may be missed in the anaphase count. The principal organisms used by the various investigators are the fruit fly (*Drosophila melanogaster*), maize, some fungi (*Neurospora*) and the flowering plant (*Tradescantia*).

Catcheside,³ a most eminent worker in cytogenetics, in discussing the irradiation-induced chromosome aberrations, distinguishes between irradiation during the resting phase of the cell and irradiation at the early prophase. During the former the chromosomes are hit when they are simple undivided threads so that both the chromatids are similarly affected. During the latter a division has already set in and therefore only one of the two chromatids is affected at a given place. It is assumed by Lea and Catcheside⁴ that the chromosome or chromatid breaks as a result of the passage through it or its immediate vicinity of a

¹ Muller, H. J. Artificial transmutation of the gene. *Science*, 1927, 66, 84-87.

² Spear, F. G. Biological effects of penetrating radiations. *Brit. Med. Bull.*, 1946, 4, 2-11.

³ Catcheside, D. G. Genetic effects of radiations. *Brit. Med. Bull.*, 1946, 4, 18-24.

⁴ Cited by Catcheside.³

single ionizing particle of a sufficiently dense ionization. Experimentally it was found that particles producing at least 200 ions per micron of track are required to accomplish a complete break in *Tradescantia*. In other cells and organisms it is different.

According to Catcheside³ the breaks in the chromosomes suffer various fates. Under certain conditions about 90 per cent of them reunite in the original way so that no permanent effect can be seen. Others undergo reunion in new ways leading partly to viable and partly to defective chromosomes. Still others never reunite, two fragments resulting in the end, one centric and the other acentric. Chromatid-breaks produce a series of analogous changes.

In the estimation of Catcheside³ the yield of persistent chromosome and chromatid-breaks is linearly proportional to the dose but is independent of the radiation intensity in case of the roentgen rays, neutrons and alpha particles. This means that simple breaks are products of single radiation hits.

However, the yields of interchanges and other two-break aberrations show a somewhat different behavior. For the roentgen rays these yields diminish with decreasing intensity. At very high intensities they are practically proportional to the square of the dose. At lower intensities they are less. A similar response is found by varying the time over which the irradiation is spread, although to prevent too much restitution of the breaks the irradiation must be completed in a relatively short time. For neutrons the yields of two-break aberrations are independent of the intensity and time of exposure and they increase in linear proportion to the dose. This behavior is explained by Catcheside by taking into consideration the two kinds of ionization which are observed with the two types of rays. The roentgen rays ionize by means of electrons. The formation of ions along the track occurs in clusters spaced apart. Only at the end of the track where the electron has lost most of its energy will there be a sufficient number of ions in a given volume to be effective. Thus the two-break aberrations

must be the product of at least two separate ionizing particles. The neutron rays ionize by means of protons. Since the ionization from such a large particle is very dense along the entire track, one particle will suffice to produce both the breaks. In other words, the chromosome and chromatid aberrations produced with the low dosages normally employed are predominantly two-hit when induced by roentgen rays and predominantly one-hit when induced by neutron rays.

The gene mutations were studied more extensively on the *Drosophila melanogaster*. It had already been observed by Muller¹ that when adult male flies exposed to radiation were mated to unexposed virgin females a certain proportion of the eggs laid failed to hatch although they had been fertilized. This was ascribed to the fact that changes in the composition of the hereditary particles which were induced by the irradiation produced a dominant lethal mutation in the sperm. Later, an effect on the sex ratio of subsequent generations was also noted.

Catcheside³ considers the following facts well established with regard to the radiation-induced gene mutations. There is no difference between the spontaneous gene mutations and those induced by the various types of radiations. The genes vary in stability and, as a rule, the less stable ones show the greatest tendency to mutation. When irradiated, the gene directly hit is more apt to be activated but what allelomorph is finally formed remains a matter of chance. There is some evidence that within certain limits back mutations are also possible. The yield of radiation-induced gene mutations is in linear proportion to the dose and independent of the intensity and time of exposure. It is also independent of the natural mutation rate of the particular stock employed. A dose of 3,000 r of roentgen rays produces a mutation rate of 12 per cent which is about 100 times that of the normal rate. This yield is the same from 2.6 Å up throughout the roentgen- and gamma-ray range commonly used but diminishes

for equal doses of other radiations in the order of roentgen rays, neutrons and alpha rays.

These facts indicate that radiation-induced gene mutations are the result of a single ionization. It is assumed that the ionization adds considerable energy to the gene directly hit, rendering it temporarily unstable and thereby altering its mutational potentialities. Not all cells are, however, equally responsive and according to Spear² various factors, such as temperature, anesthesia, state of nutrition and degree of germination may influence the mutation rate to a limited extent. From the practical standpoint it is most important that the radiation-induced mutation effect is cumulative in successive generations over an indefinitely long period of time.

A very valuable approach to the study of the genetic effect of the radiations is furnished by Gray⁵ who, in considering the ion density as the salient feature of any biologic activity, determined the linear ion density produced by the ionizing particles of the different types of radiations. This greatly simplifies the problem since it is not necessary to contrast numerous quality interrelationships but only to consider the ion density produced by a given radiation. Any ionizing particle passing through tissue gradually slows down and consequently produces an increasingly larger number of ions until it is completely arrested. The linear ion density, therefore, increases along the track, depending on the mass of the particle and the length of the path it traverses. The ionizing particles emitted by the various types of radiations are chiefly the electron, proton and alpha particle. The electron represents 1/1850 of the mass of the hydrogen atom carrying one negative charge, the proton has the mass of one carrying one positive charge and the alpha particle is four times the mass of the hydrogen carrying two positive charges. It is evident that if a very swift electron consti-

tutes the ionizing particle, its path in the tissue is much longer and thus the mean linear ion density less, whereas in the case of the bulky alpha particle the entire energy is dissipated along a very short track, and the ionization is very much higher. The magnitude of the biologic effect is to a great extent the result of the mean linear ion density and the proper spatial distribution of the ions irrespective of whether the ionizing particle is an electron, proton or alpha particle.

Gray⁵ tabulated the average values of the ion density, given in number of ions per micron of tissue, for the ionizing particles of the different types of radiation. The figures obtained are very illuminating. To quote a few examples, the mean linear ion density produced by the electron of roentgen rays of 1,000 kv. is 15, by the electron of roentgen rays of 200 kv. 80, by the proton of 900 kv. deuterium bombardment of lithium 840, by the proton of 400 kv. deuterium bombardment of deuterium 1,100, by the alpha particle of radon 3,700, by the alpha particle of slow neutron bombardment of boron or lithium 9,000 and by the atomic particles of uranium fission 130,000.

In assaying the ion-density effect on such a fundamental biologic unit as the gene, Gray⁵ states that a direct inactivation is accomplished whenever an ionizing particle leaves 2 or 3 ion pairs within the unit. The production of a chromosome-break, as shown in the experiments with *Tradescantia*, requires about 20 ions formed at one locus within the thread which corresponds to a radiation yielding at least 200 ions per micron of track. Although the phenomena occurring in animal species are more difficult of interpretation, it appears, broadly speaking, that the radiations producing the densest ionizations lead to the greatest biologic effect.

To what extent these observations are applicable to man is not as yet clear. From the point of view of chromosomal changes, it would seem that the more or less universally accepted "tolerance dose" of radiation is sufficient to protect against any ill

⁵ Gray, L. H. Comparative studies of the biological effects of x-rays, neutrons and other ionizing radiations. *Brit. Med. Bull.*, 1946, 4, 11-18.

effects and that thus in this respect there is no immediate danger. However, from the point of view of gene mutation it is a different matter. Because of the cumulative nature of the effect and since the mutational process is permanently irreversible, no "tolerance dose" can be devised to protect against such changes.

Binks⁶ raises an interesting question as regards the long-range genetic effects induced by radiations. Most gene mutations are recessive so that the inherited qualities appear only after the mutated gene meets another gene of the same kind. Muller⁷ calculated that for independent mutations this would occur after at least 30, but more probably 100 generations, amounting to a latent period of from 750 to 3,000 years. For two genes descended from the same original mutated gene this period would be somewhat longer, extending to about 5,000 years. Binks⁶ thinks that this natural muta-

tion rate may be considerably changed if a fraction of the population at one time or another is exposed to larger doses of ionizing radiations. Assuming that all spontaneous gene mutations are the result of ionization due to cosmic rays and to beta and gamma rays from radio-elements in the air, although the fact has not been definitely established, it can be shown that the human race throughout the past ages received 0.07 r per year, or doses up to 5 r during the lifetime of each person. If, for example, from now on 1 per cent of the race should receive on the average 500 r in a lifetime the natural mutation rate would be doubled. Further increase in the proportion of the population irradiated or in the total lifetime dose of the individual would result in a correspondingly higher mutational rate.

In view of the present trend toward a more general use of atomic energy and since the vast majority of the gene mutations are deleterious, the problem acquires great practical significance.

T. LEUCUTIA

⁶ Binks, W. Protective methods in radiology. *Brit. Med. Bull.*, 1946, 4, 58-64.

⁷ Muller, H. J. Role played by radiation mutations in mankind. *Science*, 1941, 93, 438; also *Nature*, London, 1941, 147, 718-719.



SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Sept. 17-20, 1946.

AMERICAN COLLEGE OF RADIOLOGY

Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1947, to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: 1947, to be announced.

AMERICAN RADIUM SOCIETY

Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: 1947, to be announced.

ARKANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Palmer House, Chicago, Ill., Dec. 1-6, 1946.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by *Secretary*. Annual meeting in May.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

RADIOLOGICAL SECTION, LOS ANGELES CO. MED. ASSN.

Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. Roy G. Giles, Temple, Texas.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. Carroll C. Dundon, 11311 Shaker Blvd., Cleveland, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB

Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DENVER RADIOLOGICAL CLUB

Secretary, Dr. A. Page Jackson, Jr., 1612 Tremont Place, Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Dell, Jr., 333 W. Main St., S., Gainesville, Fla. Meetings in May and November.

GEORGIA RADIOLOGICAL SOCIETY

Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

RADIOLOGICAL SOCIETY OF KANSAS CITY

Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets annually second Sunday in May.

IOWA X-RAY CLUB

Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KENTUCKY RADIOLOGICAL SOCIETY

Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY

Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

LOUISIANA RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

NEBRASKA RADIOLOGICAL SOCIETY

Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Neb. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library

NEW HAMPSHIRE ROENTGEN RAY SOCIETY

Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

RADIOLOGICAL SOCIETY OF NEW JERSEY

Secretary, Dr. W. H. Seward, Orange Memorial Hospital, Orange, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA ROENTGEN RAY SOCIETY

Secretary, Dr. Major Fleming, Rocky Mount, N. C.

NORTH DAKOTA RADIOLOGICAL SOCIETY

Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY

Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year, January, May, November.

OHIO RADIOLOGICAL SOCIETY

Secretary, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

ORLEANS PARISH RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC ROENTGEN SOCIETY

Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. C. L. Stewart, Jefferson Hospital. Meets first Thursday of each month, October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY

Secretary, Dr. L. M. J. Freedman, 115 South Highland Ave. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Secretary Dr. A. M. Popma, 220 N. First St., Boise, Idaho. Mid-Summer Conference, August 8, 9, 10, 1946, at Shirley Savoy Hotel, Denver, Colorado.

ST. LOUIS SOCIETY OF RADIOLOGISTS

Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY

Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly on first Wednesday at dinner.

SAN FRANCISCO RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph Levitin, 516 Sutter St., San Francisco 2, Calif. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

SHREVEPORT RADIOLOGICAL CLUB

Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.

UTAH STATE RADIOLOGICAL SOCIETY

Secretary, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

VIRGINIA RADIOLOGICAL SOCIETY

Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO

Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA

General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE ROENTGEN SOCIETY

Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

FACULTY OF RADIOLOGISTS

Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

CANADIAN ASSOCIATION OF RADIOLOGISTS

Secretary, Dr. J. W. McKay, 1620 Cedar Ave., Montreal.

SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES

Secretary, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

SOUTH AMERICA

SOCIEDAD ARGENTINA DE RADIOLOGIA

Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDAD PERUANA DE RADIOLOGIA

Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

CONTINENTAL EUROPE

CESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE

Secretary: MUDr. Roman Blána, Praha XII, Kounický 160, Czechoslovakia.

SOCIEDAD ESPAÑOLA DE RADIOLOGIA Y ELECTROLOGIA

Secretary, Dr. J. Martín-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

Secretary for French language, Dr. Babaiantz, Geneva. *Secretary* for German language, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY

Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

AMERICAN RADIUM SOCIETY

The American Radium Society held its first meeting since 1942 at San Francisco, California, on June 28 and 29, 1946. Dr. W. E. Costolow of Los Angeles, President since 1942, presided until the last session when Dr. Charles L. Martin of Dallas, Texas, was installed. The meeting was held in the Assembly Hall of the Health Building at the Civic Center. Seventy-five members were present but there was constantly an audience of one hundred and fifty.

The Janeway Lecture was given by Dr. Frederick W. O'Brien of Boston. His title was "Radium Treatment of Cancer of the Cervix; a Historical Review." The Henry Harrington Janeway Medal was presented to Dr. O'Brien by the Chairman of the Janeway Lecture Committee, Dr. Douglas

Quick of New York, at the banquet in the Fairmont Hotel on Friday evening, June 28, 1946.

The sessions were high-lighted by two significant symposia. Friday afternoon provided a program by the Department of Physics and Radiation of the University of California, Berkeley, arranged by Dr. Robert S. Stone. Hardin B. Jones, Ph.D., told of their search for radioactive compounds of specific localization, such as radioactive phosphorus, radioactive iodine, radioactive strontium and new forms of ionizing radiations from nuclear physics research.

Dr. B. V. A. Low-Beer showed colored slides illustrating skin therapy with radioactive phosphorus captured upon blotting paper. Dr. D. Harold Copp discussed the metabolism of radioactive substances and exhibited autoradiographs of bones harboring radioactive elements. Drs. L. D. Marinelli, F. W. Foote and Alfred Hocker of the Memorial Hospital, New York, presented Histologic and Autoradiographic Studies of Radioactive Iodine in Thyroid Carcinoma. Drs. Robert S. Stone (Manhattan Project) and John H. Lawrence (Cyclotron) provided discussions. These symposia will be published in early issues of the JOURNAL.

Saturday morning found the surgeons using their scalpels upon the radiologists and the radiologists replying with atomic bombs. Subject: Carcinoma of the Cervix. Dr. J. V. Meigs, Boston, and Dr. Daniel G. Morton, San Francisco, promoted radical Wertheim operations for selected cases. Drs. Harry H. Bowing, Mayo Clinic, Ira I. Kaplan and Rieva Rosh, Bellevue Hospital New York, John S. Bouslog, Denver, and George W. Waterman, Providence, upheld the arguments for radiation treatment and principally because the surgeon's criteria of operability applies to so small a percentage of cervical carcinomas. Professional politeness prevailed. The Publication Committee has nearly all of the papers and illustrations in hand and they will be published in forthcoming numbers of this JOURNAL.

The American Radium Society has 204 members. Nineteen members have been added since 1942. They are:

Atwood, Cyril John, M.D., Samuel Merritt Hospital, Oakland, Calif.

Berg, H. Milton, M.D., 221 Fifth St., Bismarck, N. D.

Blanco, Bernado Guzman, M.D., Quinto Cantacaro, El Rosal Chacao, Estado Mirando, Venezuela.

Catlin, Daniel, M.D., 620 Park Ave., New York 21, N. Y.

Chont, L. K., M.D., Winfield, Kansas.

Chamberlin, George Whitney, M.D., 6th and Spruce Sts., West Reading, Pa.

Crain, Ransome Carter, M.D., 30 N. Michigan Ave., Chicago, Ill.

Ehrlick, Harry E., M.D., 114 Morningside Drive, New York, N. Y.

Emmert, Frederick Victor, M.D., Metropolitan Bldg., St. Louis, Mo.

Guttman, Ruth J., M.D., 147-48 88th Ave., Jamaica 2, N. Y.

Heublein, Gilbert Whipple, M.D., 179 Allyn St., Hartford, Conn.

Knight, William Thomas, M.D., 210 Main St., Hackensack, N. J.

Levi, Leo, M.D., 1200 N. State St., Los Angeles, Calif.

Marinelli, Leonidas D., 444 E. 68th St., New York, N. Y.

Ovalle, Alexander, M.D., 357 E. 68th St., New York, N. Y.

Pierson, John C., M.D., 210 E. 68th St., New York, N. Y.

Scheffey, Lewis Cass, M.D., 255 S. 17th St., Philadelphia, Pa.

Verda, Dominic Joseph, M.D., Barnard Skin and Cancer Hospital, St. Louis, Mo.

Wigby, Palmer Emanuel, 1101 Medical Arts Bldg., Houston, Texas.

There have been 12 deaths and 5 resignations. The deaths are as follows:

Clarkson, Wright, M.D., Medical College of Virginia, Petersburg, Va.

Elward, Joseph E., M.D., 1726 I St. N.W., Washington, D. C.

Kasabach, H. H., M.D., Presbyterian Hospital, New York, N. Y.

Keith, David Y., M.D., 1010 Heyburn Bldg., Louisville, Ky.

Murphy, John T., M.D., 421 Michigan St., Toledo, Ohio.

Taussig, Fred J., M.D., Beaumont Medical Bldg., St. Louis, Mo.

Tyler, Albert F., M.D., 1216 Medical Arts Bldg., Omaha, Neb.

Simpson, Burton T., M.D., 633 N. Oak St., Buffalo, N. Y.

Levin, Isaac, M.D., 57 W. 57th St., New York, N. Y.

Strauss, Abraham, M.D., 25 Prospect Ave. N.W., Cleveland, Ohio.

Soiland, Albert, M.D., 1407 S. Hope St., Los Angeles, Calif.

Stevens, Rollin H., M.D., 1429 Whitney Bldg., Detroit, Mich.

The death of Dr. Marion Truehart of Sterling, Kansas on July 11, 1946, has just been reported.

The new officers are as follows: *President*, Dr. Charles L. Martin, Dallas, Texas; *President-Elect*, Dr. A. N. Arneson, St. Louis, Mo.; *First Vice-President*, Dr. Maurice Lenz, New York, N. Y.; *Second Vice-President*, Dr. Wm. S. MacComb, New York, N. Y.; *Secretary*, Dr. Hugh F. Hare, 605 Commonwealth Ave., Boston 15, Mass.; *Treasurer*, Dr. Leland R. Cowan, Salt Lake City, Utah.

The next annual meeting will be held in June, 1947, in New York or Atlantic City. The definite date and place becomes a function of the Executive Committee now composed of Dr. W. E. Costolow, Los Angeles. Dr. Hayes Martin, New York, and Dr. Frederick W. O'Brien, Boston, Chairman.

EDWARD H. SKINNER

RADIOISOTOPES FROM THE MANHATTAN PROJECT

A detailed announcement on the availability and procurement of pile-produced radioisotopes from the Manhattan Project appears in the June 14, 1946, issue of *Science*.*

Tables are included giving pertinent data on the characteristics and the quantities which may be made available of around 100 isotopes and isotopic mixtures. For practical reasons isotopes with a half-life

* Availability of radioactive isotopes. *Science*, June 14, 1946, 103, 697-705.

less than twelve hours are not considered for distribution. Most of the isotopes are produced by fission or (n,γ) processes. Only four isotopes are produced by the (n,p) process with sufficient yield for distribution. Other processes are either not sufficiently productive or do not occur.

The article emphasizes that (1) present piles were not designed for tracer and therapeutic isotope production, (2) waste plutonium process solutions are not a feasible source for separated fission isotopes, (3) routine production methods and facilities are not yet developed for most isotopes, (4) isotopes which can now be made available are only experimental lots resulting from research and development proceedings, (5) technical problems involved in the irradiation and processing of essential materials has been and will continue to be responsible for the delay in making certain isotopes available by routine production.

Allocation and distribution will be effected on the basis of the general policies, as well as on recommendations regarding specific applications, made by well qualified advisory groups nominated for Manhattan District appointment by the National Academy of Sciences. Charges will be made for materials and services on the basis of "out-of-pocket" operational expenses to the Government necessitated by the non-project production and service program. Costs for construction or rental of major plant facilities and expenses of research and development on isotope production will be assumed by the Project.

All correspondence concerning radioisotope procurement should be addressed to the Isotopes Branch, Research Division,

Manhattan District, P. O. Box E, Oak Ridge, Tennessee. Reference to the original article for pertinent details is recommended, however, before instituting inquiries or requests.

AMERICAN COLLEGE OF PHYSICIANS

The American College of Physicians announces its Twenty-eighth Annual Session to be held in Chicago, Illinois, April 28-May 2, 1947. Dr. David P. Barr, New York, is President of the College and will be in charge of the program of General Sessions and Lectures. Dr. LeRoy H. Sloan, Chicago, has been appointed General Chairman, and will be in charge of the program of Hospital Clinics and Panels, as well as local arrangements, and entertainment. Mr. Edward R. Loveland, Executive Secretary of the College, 4200 Pine Street, Philadelphia 4, will have charge of the general management of the session and the technical exhibits.

Other medical societies are urged to note these dates in order that conflicts in meeting dates may be avoided for mutual benefit.

E. R. LOVELAND
Executive Secretary

PITTSBURGH ROENTGEN SOCIETY

At the last business meeting of the Pittsburgh Roentgen Society, held in The Ruskin, Pittsburgh, the following officers were elected for the coming year: *President*, Harold W. Jacox, M.D., Pittsburgh, Pa.; *Vice-President*, William T. Rice, M.D., Rochester, Pa.; *Secretary-Treasurer*, Lester M. J. Freedman, M.D., Pittsburgh, Pa.



BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

Semiologia Clinico-Radiologica de la Tumores del Abdomen. By Dr. F. García Capurro, Prof. Agregado de Radiología, and Dr. Raúl Piaggio Blanco, Prof. de Clínica Médica, de la Facultad de Medicina de Montevideo. Paper. Pp. 566, with 351 illustrations. Espasa-Calpe Argentina, S. A.—Buenos Aires—México, 1946.

During the past thirty years the diagnostic procedures of abdominal tumors have undergone numerous changes, due chiefly to the continuous development of new roentgen techniques of examination. The authors have assembled all the material available on the subject and, after skillfully co-ordinating the various findings, have compiled an excellent up-to-date treatise of clinical radiological semiology.

The work is divided into two main parts. The first deals with general considerations which are taken up in three chapters. One chapter gives a lengthy discussion of the anatomic, structural and dynamic peculiarities of the abdomen and their importance from the roentgenological standpoint, another the fundamental principles of clinical roentgen diagnosis and the third is a general review of the anatomic modifications provoked by the abdominal tumors.

The second part of the book contains seven additional chapters, dealing with the regional syndromes as follows: IV, tumors which occupy the entire abdomen; V, tumors of the right and left thoraco-abdominal regions; VI, tumors of the region of the left hypochondrium and the left flank; VII, tumors of the region of the right hypochondrium and of the right flank; VIII, tumors of the celiac region; IX, tumors of the right and left iliac fossae, and X, tumors of the hypogastric region and of the pelvis.

Each of the chapters is richly illustrated with typical roentgenograms in various views and with numerous schematic diagrams. A bibliography of 544 articles is appended.

The material is presented in a clear and concise manner. The book is well made and its printing is irreproachable.

T. LEUCUTIA

KURZWELLENTHERAPIE. Von Dr. Josef Kowarschik, Professor für physikalische Therapie an der Universität Wien. Third edition. Cloth. Price, \$4.25. Pp. 143, with 138 illustrations. Wien: Springer, 1943. J. W. Edwards, Publisher, Ann Arbor, Michigan.

In the foreword to the third edition of his book, the author states that the heated discussions and overproduction of literature regarding short wave diathermy have now quieted down. Many of the highly debatable issues have been completely dropped because in his opinion they represented mostly "pseudo problems." Therefore very few changes and additions were required in this new edition as compared with the previous one.

In the theoretical part he discusses the physics of short electric waves and describes the apparatus and technique of application. This is followed by a brief chapter dealing with the biologic effect of short electric waves. For the radiologist it is interesting to note that the author does not believe in the successful treatment of malignant neoplasms in the human with short electric waves. The only efficient method would be destruction by electrocoagulation. Likewise he does not consider practical the sensitization of tumors by short electric waves preceding irradiation by roentgen rays or radium. In the clinical section he outlines the therapeutic use of the short electric waves in the treatment of diseases affecting the various organs. The concluding chapter is devoted to fever therapy. Each section is supplemented by a selected bibliography and the monographs and books on the subject are compiled at the end of the text. The index is adequate while the illustrations are not too clear. This, however, could probably not be avoided because of wartime conditions and the type of paper used. The author is well known in his field and the book presents, therefore, a good picture of the status of short wave diathermy in Europe about 1940.

ERNST A. POHLE

RÖNTGENPHYSIK. Von Dr. med. Adolf Liechti, Professor für medizinische Radiologie; Direk-

tor des Röntgeninstitutes der Universität Bern. Mit Beiträgen von Dr. phil. Walter Minder, Technischer Leiter des Institutes der Bernischen Radiumstiftung. Cloth. Price, \$11.75. Pp. 308, with 227 illustrations. Wien: Julius Springer, 1939. J. W. Edwards, Publisher, Ann Arbor, Michigan.

This excellent treatise on the physical foundations of roentgen rays was written in 1939 by the radiologist of the University of Bern. It also contains chapters written by W. Minder, physicist and technical director of the Bern Radium Institute. Minder's chapters deal with radiations from radioactive substances, artificial radioactivity and isotopes; measurement of alpha, beta and gamma rays of radium; and non-medical applications of roentgen rays. In the preface Liechti states that "without the most exact knowledge of its physical foundations a beneficial application of radiology in medicine is unthinkable," and he proceeds to furnish such exact knowledge in the text. There are detailed chapters on character and properties of short wave radiations, interrelationships between

roentgen rays and the structure of the atom, absorption and scattering of roentgen rays, roentgen-ray generators and roentgen tubes. The author also describes the physical, chemical and biological effects of roentgen rays, roentgen-ray and radium dosimetry, protection against various types of radiation, and finally many special technical procedures such as kymography, cinematography, tomography, and stereoscopy.

The subjects are mostly treated in detail and all are written with authority. A few chapters, such as that on practical dosimetry of roentgen rays and radium, are relatively short and in places inadequate to answer practical questions of the average radiologist. Other chapters, for instance those on atomic physics or on various effects of short wave radiations, present a great deal of information and are in some cases entirely up to date. The book can be highly recommended to radiologists although some knowledge in fundamental physics is required for full appreciation of its contents.

OTTO GLASSER



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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

- CAMPBELL, JAMES B., and ALEXANDER, EBEN, JR. Eosinophilic granuloma of the skull. *J. Neurosurg.*, Nov., 1944, 1, 365-370.

Eosinophilic or solitary granuloma of the bone is a granulomatous lesion of bone which affects children and young adults predominantly and more often the male. It is of unknown origin but some authors classify it as the most benign form of a generalized disease process of which Hand-Schüller-Christian disease is the most insidious and chronic and Letterer-Siwe disease the most malignant and severe, the latter occurring in the youngest age groups. At times the various lesions of these diseases are indistinguishable. Jaffe and Lichtenstein feel that the basic disorder is an inflammatory histiocytosis in response to an unknown infectious agent. Clinical manifestations of the three conditions vary and differ greatly save from the roentgenographic viewpoint. The lesion in eosinophilic granuloma is not always solitary; in half of the reported cases the skull has been involved alone or with other bones. No reports of involvement of the skull in other than bones of the vault have been made nor has any involvement of the bones of the hands or feet been reported. The lesions begin in the medullary cavity, erode and expand the cortex. In the skull, erosion occurs inward or outward. The tumor is soft and hemorrhagic composed of aggregates of phagocytes with conspicuous collections of eosinophiles. General symptoms are lacking, local pain is the usual initial complaint. No abnormal laboratory studies have been reported save for mild eosinophilia.

On roentgen examination, the lesions are of varying size, radioluscent and are sharply outlined when they occur in the skull. They must be differentiated from many conditions. Final

diagnosis must be made by biopsy. Simple curettage or wide extirpation have been used successfully. Roentgen therapy alone using 1,500 r through two fields in six days has produced satisfactory disappearance of the lesions. Spontaneous resolution of the lesions has been observed. The prognosis is generally good. The case of a twenty-seven year old male with an eosinophilic granuloma of the frontal bone is reported. There was a history of antecedent trauma, which according to some is etiologic. Successful excision was accomplished. —*Leo A. Nash.*

- GOODYEAR, HENRY M. Mucocoele in frontal and ethmoidal sinuses; simplified surgical treatment. *Ann. Otol., Rhin. & Laryng.*, June, 1944, 53, 242-245.

A mucocoele may occur in any of the nasal accessory sinuses but is more frequently found in the frontal and anterior ethmoid cells, occasionally in the antrum and rarely in the sphenoid sinus.

Etiology. Thomson and Negus state that a mucocoele usually occurs with an "obstruction in the outlet of the cavity and it may be caused by blockage and cystic dilatation of a gland."

By a process of slow constant pressure there is a slow absorption of bone, and often the floor of the frontal sinus and the lamina papyracea are destroyed.

Signs and Symptoms. A slight disturbance of vision progressing to a diplopia and often accompanied by a dull headache, which may be increased on movement of the eye, constitutes the first symptom of a mucocoele. Thus, these patients usually come first to the attention of the ophthalmologist.

The onset is insidious and usually without pain. Later, the eye is displaced forward, downward and laterally. Diplopia, limited motion of the globe and a variable degree of impaired

vision may be present. Ptosis of the lid, epiphora, and even atrophy of the optic nerve may occur.

There may be "parchment-like" crackling on palpation, and if pulsation is present it means that the posterior wall of the frontal sinus or the floor of the ethmoid, or both, have been absorbed, and the mucocele is lying in contact with the dura mater.

If infection leads to a pyrocele, the swelling may be red and tender and the temperature may be much like that in an acute frontal sinus infection.

Intranasal examination is usually marked by the absence of polypi or pus. The ethmoid bulla may be expanded and lowered.

Roentgen Findings. Early, there are no characteristic roentgenographic findings but with advancement, defects in the orbital and sinus wall occur. The frontal sinus loses its scalloped appearance and the marginal densities become smooth and regular.

Differential Diagnosis. (1) Ostomas are equally insidious and painless in onset but roentgenograms show a sharp demarcated outline of dense bone and in advanced cases there is no "parchment crackling" or pulsation on palpation. (2) Malignant neoplasms are usually much more rapid in growth and usually show redundant, soft, free bleeding tissues in the ethmoid area. (3) Other lesions to be differentiated include gummas, aneurysms, fibromas, angiomas, lymphoid tumors, meningoceles and chronic sinus infections.

Treatment. The author feels that the epithelium lining the mucocele in the frontal sinus can do no harm so he does not remove it in operating upon these lesions.—*Mary Frances Vastine.*

DOWLING, JAMES R. Osteoma of the frontal sinus. *Arch. Otolaryng.*, Feb., 1945, 41, 99-108.

Definition. Ewing stated that the bony structure of an osteoma of the cranial bones may be ivory-like with solid lamellas and few or no haversian canals, or it may be spongy with cancellous tissue and may contain narrow cavities or spaces.

Incidence. Osteoma of the frontal sinus is by no means a common lesion. The author feels fortunate in having seen osteoma of the frontal sinus in 5 patients within the year 1944 at the Army hospital where he is stationed. Two of the patients were German prisoners of war. The author believes that the higher incidence of the

lesion in the Army camps is explained by the fact that osteoma of the frontal sinus as statistics have shown, is chiefly a disease of youth and is more common in males.

Etiology. The frontal sinus is the most frequent site for the development of osteoma of the nose and nasal accessory sinuses. Fetissof after a survey of over 200 cases reported that in 50.7 per cent the osteoma was situated in the frontal sinus, in 40 per cent in the ethmoid labyrinth, in 6.2 per cent in the maxillary sinuses and in 3.1 per cent in the sphenoid sinuses.

Osteoma of the frontal sinus is essentially a lesion of youth and the greater incidence is found between the second and third decades of life.

The cause of osteoma is unknown. In 2 of the author's cases, roentgen study revealed osteitis of the frontal bone for a small area lateral to and above the upper margin of the sinus. This was found surgically to have an appearance of osteitis and it was at this site that the true tumor mass was attached, which suggests the possibility of periosteal inflammatory processes being a strong factor in the causation of the growth.

Pathology. Osteoma is a benign tumor, the growth of which is usually very slow and which is malignant only mechanically.

Morphologically, two types are recognized: the hard, ivory-like eburnated type and the softer, cancellous one. Microscopically, there may be great variations. Ewing stated that at times it is difficult to differentiate certain forms of osteoma from simple hypertrophy of bone.

Symptoms and Diagnosis. In many cases the diagnosis comes only by roentgen examination because of the silent nature of these growths. Dizziness, headaches and deformity are the cardinal symptoms.

The extension of the tumor mass may be in one or in all of three directions, namely, externally through the outer table, internally into the anterior cranial fossa and, lastly, inferiorly in the orbit. The symptoms, then, will depend on the structure on which the pressure, due to the expanse of the growth, is being directed.

Treatment. The only treatment for osteoma of the frontal sinus is surgical removal.—*Mary Frances Vastine.*

PROFANT, H. J. Temporal arteritis. *Ann. Otol., Rhin. & Laryng.*, June, 1944, 53, 308-325.

Composite Picture of Temporal Arteritis. The

patient, most likely a white woman around sixty years of age or over, complains of severe pain in the temporal region. Her internist will state that the patient has a fever, leukocytosis, general malaise, and sweats. Every known test has been made and found negative. It is hoped that the otolaryngologist will locate a sinusitis which is causing the severe pain and general symptoms. No sinusitis is found and the pain is not relieved by cocaineization of the ethmoid and sphenoid areas. In from two to six weeks after this examination a bright red, tortuous swelling of the temporal artery appears. The patient is then informed that she has a "temporal arteritis" which will cause symptoms for many weeks or months and then gradually subside. Thus far, no fatal case has been reported. In the reports, however, eight patients were found to have an associated retinal arteritis with permanent diminution of vision or complete blindness.

Summary of the Literature. In practically all of these case reports the question of a sinusitis arose. In over 50 per cent, painful mastication at the onset is mentioned. This indicates that the inflammation of the temporal artery extended down or, in fact, may have originated at, or below, the temporomandibular joint region.

The youngest patient was fifty-five years of age and the oldest eighty. The average age was sixty-seven and there were three times as many women as men. All were of the white race.

The shortest duration was one month and the longest twenty months; the average was nine months.

The age level and prolonged course with recovery are distinctive clinical features of a temporal arteritis.

Diagnosis and Treatment. In the author's 2 cases a diagnosis was made by the clinical picture in which a tender, red, tortuous, nodular temporal artery appeared. In the first case this occurred five weeks after the onset of the temporal pain, and in the second case, two weeks. The marked nodular swelling of the inflamed artery could be observed at a distance of 10 feet from the patient.

Sulfonamides were tried and discontinued. The author did not feel that a resection of a segment of the artery had therapeutic value. His 2 patients made a complete and spontaneous recovery. However, 1 of these patients had a severe acute exacerbation of the temporal arteritis following extraction of three infected

teeth. This episode would verify the opinion of some previous writers that a focus of infection is the causative factor.

Pathology. The microscopic pathology in temporal arteritis is essentially the same as in periarteritis nodosa. (However, the clinical picture is entirely different.)—*Mary Frances Vastine.*

DANELIUS, GERHARD. Value of the axial projection of the petrous bone in the diagnosis of chronic mastoiditis and cholesteatoma. *Radiology*, Nov., 1944, 43, 492-498.

Good views of the structures in or near the mastoid antrum and tympanic cavity, which are most frequently involved in chronic mastoiditis, are rarely obtained by the routine projections. The author therefore describes in detail and illustrates with roentgenograms an axial projection introduced some twenty years ago by Ernst G. Mayer of Vienna. It is rather difficult technically and distorts all the petrous bone except the mastoid antrum, attic, tympanic cavity and the wall of the posterior auditory canal and so has not become popular in the United States. The author gives this technical description in the hope of stimulating interest in this very valuable projection. It gives a surprising wealth of detail in regard to the antrum, attic, tympanic cavity and wall of the posterior auditory canal, "as if a curtain had been lifted from them."

It is not possible to differentiate solely on roentgen evidence between an undeveloped, diploic, undiseased mastoid and a chronic, sclerotic mastoid, but if the ear is diseased clinically a chronic sclerotic mastoiditis may be assumed. When a cholesteatoma has reached a considerable size it can be diagnosed during a quiescent stage by its smooth, regular outline. But during an acute attack this outline becomes blurred, making it difficult to differentiate between such a cholesteatoma and a granulomatous, purulent, enlarged antrum. But the presence, size and exact position of the cavity in the petrous bone can be reported. A post-operative defect may resemble a cholesteatoma but the history of operation should differentiate between them.

In the typical pathological case the findings are so characteristic that the percentage of roentgen errors is very low after the examiner has had experience in analyzing these roentgenograms.—*Audrey G. Morgan.*

KAUTZ, FRIEDRICH G., and SCHWARTZ, IRVING. Intra-ocular calcium shadows; choroid ossification. *Radiology*, Nov., 1944, 43, 486-491.

Few cases of calcification in the eyeball have been demonstrated roentgenologically although it has long been known to ophthalmologists from clinical examination and dissection of the enucleated eye. The literature of the subject is reviewed and 7 cases of intraocular calcification described and illustrated with roentgenograms. Shadows caused by intraocular calcium can be differentiated easily from those caused by foreign bodies, incomplete removal of metallic dust and residual thorotrast following roentgen examination of the orbit.

The roentgenogram usually shows a shrunken orbit, with a dense ovoid, circular or semi-circular calcium shadow in the center of it. The shadow is not strictly homogeneous; it occupies the region of the lens and extends into the posterior part of the eyeball more frequently than into the anterior part. Pathologic examination shows a shell-like ossification of the choroid and lens. The majority of the authors' patients were middle aged and most of them had a history of foreign body injury of the eye. In some cases there were no symptoms and the calcification was found incidentally on roentgenography of the sinus.

There are three methods of demonstrating these intraocular calcifications—by a postero-anterior projection of the orbit, by an additional lateral view such as is used for foreign body localization and by a bone-free technique which eliminates the surrounding bones. The authors have had satisfactory results from all three methods. The orbit should be examined in any roentgen study of the facial bones, skull and sinuses.—*Audrey G. Morgan.*

LITTLE, SAMUEL C., and PASCUCI, LUCIEN M. Basilar impression and associated deformities—case report. *New York State J. Med.*, Mar. 15, 1945, 45, 638-642.

There are a number of anomalies and deformities of the skull and upper part of the spine which, though comparatively rare, are frequent enough to be of importance in differential diagnosis from other organic lesions in this region. Their cause is not yet known but it is probable they are all variants of one abnormal process of development. They include the Arnold-Chiari deformity, in which displace-

ment of parts of the cerebellum takes place into the upper vertebral canal and the fourth ventricle is elongated so that it opens into the spinal subarachnoid space below the level of the foramen magnum; or there may be downward herniation of the whole cerebellum into a cervical spina bifida and meningocele. Ordinary roentgenograms of the head and neck of patients with this deformity, if uncomplicated, do not show any abnormality but myelographic studies may show obstruction of the upper cervical canal and foramen magnum by the herniated cerebellum and medulla.

The Klippel-Feil deformity usually consists of a defect of the atlas, a cervical spina bifida and fusion of some of the cervical vertebrae. In spina bifida with its congenital cleft of the vertebral column the spinal cord remains in the sacral or lower lumbar region and may be injured by lumbar puncture; there is degeneration of the cord as a result of stretching and true syringomyelia-like cavities, not due to hydrocephalus, appear in the cervical cord. The fixation of the cord is not necessarily accompanied by any bone defect that can be demonstrated roentgenologically. Basilar impression is a deformity of the base of the skull in which the foramen magnum is distorted and seems to have been pushed up into the posterior fossa. The atlas may be assimilated into the occipital bone, the lower part of the odontoid process encroaching on the cervical portion of the spinal canal and the upper part projecting into the foramen magnum. This condition is often associated with the Arnold-Chiari deformity, the Klippel-Feil syndrome, spina bifida, syringomyelia and other manifestations of spinal dysraphia.

Roentgenograms of these conditions are given and a case described in a soldier twenty-seven years of age who was admitted to hospital complaining of weakness of the left arm and leg. A roentgenogram showed basilar impression. A suboccipital decompression operation was performed and the patient's condition improved greatly. The dura was not opened so it is not known whether there was also an Arnold-Chiari deformity.—*Audrey G. Morgan.*

OLSEN, AXEL, and HORRAX, GILBERT. The symptomatology of acoustic tumors with special reference to atypical features. *J. Neurosurg.*, Nov., 1944, 1, 371-378.

The symptomatology of tumors of the cerebellopontine angle, particularly the acoustic

neuromas, as summarized by Cushing, includes auditory and labyrinthine disturbances, occipitofrontal pains and occipital discomfort, cerebellar incoordination and instability, evidence of adjacent cranial nerve involvement, indications of increasing intracranial pressure, dysarthria and dysphagia, and cerebellar crises, and death in progressive order. Olsen and Horrax, reviewing 42 cases of acoustic neuromas found essential agreement with the above. In addition, certain features were noted such as the absence of tinnitus in 38 per cent of cases and while it was noted about the same time as deafness it preceded hearing loss in only 4 cases. Headache is less significant of increased pressure than pressure on the fifth cranial nerve. Nystagmus was present in all. Caloric examination was not made in 9 patients but an absent response on the involved side was noted in all undergoing this procedure, and the authors stress its value since it may obviate ventriculography or lumbar puncture. In 15 cases examined roentgenologically, 9 showed positive findings and in no case was plain roentgen examination the final diagnostic criterion. In 8 cases, ventriculography was used to determine the type of approach or to differentiate tumor from some other lesion.—*Leo A. Nash.*

NECK AND CHEST

MASON, MALCOLM W. Photofluorography for chest surveys. *Radiology*, Nov., 1944, 43, 499-503.

It is of very great importance in the control of tuberculosis to detect the early unsuspected cases so as to place them under treatment and prevent the spread of the disease. This can now be accomplished to a very great degree by photofluorography.

There are four methods of conducting mass surveys for tuberculosis. The first is by the use of the standard 14×17 inch film, the second by the use of 14×17 inch paper films, the third by the photofluorographic method, using 4×5 inch films with stereoscopic views. The author believes this is the most adequate. The fourth method is by the use of 35 mm. films. This method is also adequate and reliable and the cost is very low. This was the method used by the author at the Great Lakes Training station. He gives a report of results in 400,263 chest examinations at the Naval Training Station at Great Lakes. In a total of 41,616 examinations made with the 35 mm. film there were 16 errors

which were errors in interpretation and not due to the method as such. Since the beginning of the survey 6 patients with negative diagnoses have been hospitalized with active tuberculosis. This may have been due to overlooking the lesion on account of its smallness and the smallness of the film or it may have been due to the fact that the disease developed between the time of the examination and that of hospitalization.

There is no doubt that these examinations have been of great value to the government in keeping men out of the service who were not able to go in. It is estimated that by these 400,263 examinations the government was saved more than \$22,000,000.

Though the method with the 4×5 inch film is more reliable than that with the 35 mm. film the latter is reliable enough for practical purposes and is more rapid and less expensive.

It is believed that if this method of mass examination could be extended to the whole population tuberculosis might be practically eliminated.—*Audrey G. Morgan.*

ALPERN, ALGERNON N., and BENJAMIN, JULIEN E. The induction film as an aid in appraising subsequent pulmonary lesions. *Radiology*, Dec., 1944, 43, 548-562.

The most important problem in tuberculosis in the Army, as well as in civilian life, is the detection of early slight lesions that are not causing symptoms. On January 1, 1941, the Army assumed full responsibility for the roentgen-ray service at induction centers and the Surgeon General's Office issued an order that chest examinations include a roentgenogram with special attention to the detection of tuberculosis. All roentgenograms made at the time of induction are filed for permanent record and are of great value in studying the subsequent history of the cases. At United States Army Induction Center No. 6, disqualifying lesions were found in 1.2 to 1.3 per cent of cases.

Cases are considered acceptable for military service when they have healed primary intrathoracic tuberculosis lesions of small size. The sizes of such lesions are fixed arbitrarily and the fact that an inductee is passed does not necessarily mean that he will not have tuberculosis later. Cases that might remain quiescent in civilian life may be reactivated by the worry and over-fatigue of military training.

From January 1, 1942 to January 1, 1943, 4,019 patients were admitted to Lovell General

Hospital. Of these, 122, or 3.03 per cent, were admitted directly to the tuberculosis ward for proved or suspected tuberculosis; among these there were 14 cases of non-pulmonary tuberculosis. Of the 108 remaining patients 23, or 21.3 per cent, were admitted solely on the basis of routine roentgen examination of the chest. In 11 of these cases the tuberculosis was proved to be active, and in 6 this could be proved only by serial roentgen examinations. The laboratory tests were negative.

Induction roentgenograms were available from the Veterans' Bureau or civilian hospitals in 21 cases. In 1 patient with a negative induction roentgenogram tuberculosis developed nine months later. Thirteen patients had demonstrable lesions at the time of induction. Four of these had been considered acceptable under the rule defining acceptability. In 2 of these cases the lesions proved to be active and showed progression when the patients were hospitalized. In the other 2 they had remained stationary. These examples show the value of roentgenograms taken at induction but this value depends on the quality of the photography and the care with which the roentgenograms are interpreted. Among the 3,897 patients admitted to hospital with other than tuberculous conditions 26 were found on roentgen examination to have asymptomatic pulmonary tuberculosis. During the past two years there have been an increasing number of atypical pneumonias. These are very hard to differentiate from tuberculosis, and prolonged observation until they are resolved is often necessary.

The so-called lordotic view is often valuable in the demonstration of small lesions at the apex which are partly hidden by the clavicles or bones of the thorax. Illustrative roentgenograms are given.—*Audrey G. Morgan.*

MOEHLIG, ROBERT C., and ULCH, HAROLD W. Multiple parathyroid adenomata; three operative explorations with removal of two tumors. *Harper Hosp. Bull.*, Dec., 1944, 2, 41-49.

Multiple adenomas of the parathyroid are by no means uncommon. A case is described in a man of sixty-two admitted to Harper Hospital November 13, 1938, with frequency and burning on urination, nausea and vomiting after meals and stiffness of the knees, ankles, shoulders and elbows. He had had tuberculosis twenty-five years before with complete arrest

after a year of treatment. Bladder stones had been removed twenty-one years before.

Roentgenograms showed considerable demineralization of the bones such as is seen in parathyroid disease. From this and the clinical symptoms a diagnosis of parathyroid tumor was made and operation performed on February 8. A light brown tumor which proved on examination to be a parathyroid adenoma was removed from the lower pole of the thyroid gland. The right side was not examined. The clinical symptoms as well as the hypercalcemia and high serum phosphatase persisted and on February 28 an exploratory operation was performed which did not reveal any further tumors. But as weakness and dyspnea increased a third operation was performed on July 12. A yellowish-brown tumor was found on the left side that proved to be a parathyroid body intermingled with remains of a thymus. The patient died three days later of heart failure.

The question is considered as to whether the high caloric and high calcium diet given for tuberculosis twenty-five years before had overburdened the parathyroids and whether parathyroidism in a subclinical form was present at the time of the removal of the bladder stones twenty-one years before. There were no clinical signs of parathyroidism at the time.

This case illustrates the fact that careful examination should be made on both sides even if a large tumor is found on only one side. Special skill is necessary in operating on the parathyroids, even greater than that ordinarily required for removal of the thyroid. The problems to be considered are those of the anatomy and physiology of the parathyroids rather than those of the regional anatomy of the neck.—*Audrey G. Morgan.*

MOORE, NORMAN S., WIGHTMAN, HENRY B., and SHOWACRE, EDWARD C. Primary atypical pneumonia. I. A statistical report of 196 cases. *New York State J. Med.*, Apr. 15, 1944, 44, 869-872.

Eighty-six cases of this new disease were reported from Cornell University in 1939 under the name of acute interstitial pneumonitis. It is known by various names and is seen chiefly in young adults of military age. It has assumed such importance that the Surgeon General has appointed a special commission to study it.

This article discusses 196 cases seen at Cornell University from 1937 to 1941. The average age was 20.4 years; 84 per cent were in

males; 73 per cent of the cases occurred between July and January; 58 per cent of the cases were mild, 30 per cent moderate and 11 per cent severe. There were no deaths. In 10 per cent of the cases the onset was sudden, within a few hours, but in the majority of cases it was gradual. Cough was the most constant symptom in hospital, occurring in 90 per cent of cases. The hospital fever averaged 5.94 days; there was pleurisy in 20 cases. An irregular, peaked temperature curve was seen in all moderate and severe cases; the left lower lobe alone was involved in 43 per cent of the cases, the right lower lobe alone in 66 per cent. The prognosis was good but there was prolonged disability which rendered the disease important from the military point of view.

Treatment in general was symptomatic. The author believes that sulfonamide treatment is indicated though it does not have any direct effect on the disease itself. A failure to react to sulfonamides helps in the differential diagnosis of a typical pneumonia and the sulfonamides even in low dosage help to control the pathologic bacteria of the respiratory tract and so to reduce the subsequent complications of the disease.—*Audrey G. Morgan.*

SHOWACRE, EDWARD C., WIGHTMAN, HENRY B., and MOORE, NORMAN S. Primary atypical pneumonia. II. Observations of radiographic patterns. *New York State J. Med.*, Apr. 15, 1944, 44, 872-879.

The authors first saw primary atypical pneumonia at Cornell University in 1935. In the nine years since then they have made roentgen studies of a number of epidemics and give roentgenograms showing the typical appearances seen. Generally there are no roentgen signs until thirty-six hours or more after the first beginning of symptoms. The shadows generally appear within from thirty-six to seventy-two hours after the beginning of symptoms and spread in area and become denser or confluent. The common pattern which occurs in about half the cases shows increased density of the hilum, swelling of the larger trunk branch shadows and the presence of finer branch shadows which are not visible normally. These linear shadows are soon obscured but not obliterated by a veil of haze which extends in a fan shape from the hilum into the adjacent lung. The fine nodular type is essentially the preceding type plus scattered denser, soft nodular areas. In the reverse fan type, the fan

previously described has its apex at the periphery and the fan spreads toward the hilum. In the hilar type there is increased density of the hilar structures on one or both sides without involvement of the lung fields. Lobar consolidation was seen in only 1 per cent of the cases. Apparent atelectasis, manifested by lobe contraction and elevation of the diaphragm was rarely seen.

The three varieties of spread seen were the continuous, the unit and the explosive types, which are described. There were two types of clearing. The fan types became less dense and disappeared within a week from beginning resolution. All of the nodular and some of the homogeneous density types gradually lost their soft appearance and a more organized type of infiltrate appeared. A case first seen during this stage might be considered one of chronic lung disease. Complete resolution usually required from one to two weeks. The longest time seen from the beginning of resolution to complete clearing was ten weeks.

While the roentgen image in this disease is characteristic is not diagnostic in the majority of cases. Similar patterns may be seen in inflammatory reactions from various irritants, such as virus, rickettsia, protozoa, fungi, bacteria, chemical fumes or mechanical agents. In order to make a correct diagnosis, the history, clinical findings and bacteriological and roentgenographic evidence must all be taken into consideration. The disease is best differentiated from other lung diseases by serial roentgenograms.—*Audrey G. Morgan.*

ELKELES, A., and GLYNN, L. E. Serial roentgenograms of the chest in periarteritis nodosa as an aid to diagnosis, with notes on the pathology of the pulmonary lesions. *Brit. J. Radiol.*, Dec., 1944, 17, 368-373.

Periarteritis probably represents an extreme hyperergic response of the vascular system to foreign serum and other sensitizing antigens, such as bacteria and their products. The lungs are not as frequently involved as some other organs so few roentgen examinations of the chest have been recorded. But the author believes that serial roentgenograms of the chest may aid in diagnosis of this disease, in which diagnosis is very difficult, and he therefore presents descriptions and serial roentgenograms of 2 cases, one of which was followed up for five months.

The roentgenograms showed patchy infiltra-

tions in both upper lobes which may have been caused by small infarctions. The hilar shadows were enlarged and of increased density. The pulmonary vessels appeared as dense wavy streaks gradually fading towards the periphery. The patchy infiltrations suggested tuberculosis but the fact that they disappeared without leaving scarring argued against this interpretation. In later examinations there were enlarged dense hilar shadows interspersed with areas of intense density almost suggestive of aneurysmal dilatation of the pulmonary vessels with thrombus formation. There was fibrosis and diffuse mottling in the adjacent mesenchymal structures. In a late stage of the disease pleural effusion developed first on the left side and then on both sides.

In the pathological notes a wide rim of perivascular scar tissue is described around the smaller arteries. There was complete loss in places of the internal elasticity of these vessels and thickening of the intima resulting in some areas in almost complete obliteration of the lumens of the vessels by cellular granulation tissue. No acute lesions of periarteritis nodosa were seen.

Specific changes of periarteritis nodosa are seen in the lungs in only about 30 per cent of the autopsy cases, though they must be much more frequent during life, as evidenced by experimental work on rabbits. Five out of 12 rabbits in which the disease was produced by inducing hypersensitivity to foreign serum showed typical vascular lesions in the lungs.—*Audrey G. Morgan.*

DUNNER, LASAR, and HERMON, R. Further observations on lung disease in boiler-scalers. *Brit. J. Radiol.*, Dec., 1944, 17, 355-358.

In a previous paper (*Brit. J. Radiol.*, Oct., 1943, p. 287) one of the authors said that the opacities in lung disease in boiler-scalers were uniformly distributed in both lungs. In the study of the 5 cases reported in this paper they found that this is not true but that the lesions may be variously distributed. They believe that in all cases which show even minor evidences of fibrosis, increased striation or reticulation, a careful study of the history should be made for possible pre-existing occupational pneumoconiosis, even if the disease for which the patient is admitted is tuberculosis or carcinoma. Regular routine roentgen examinations should be made also. There was a history of occupa-

tional disease before the development of the tuberculosis or carcinoma in all of the 5 cases reported. Roentgenograms at various stages of the disease are given. Men in the service may be given compensation for tuberculosis when, as a matter of fact, it should be given for a pre-existing occupational pneumoconiosis.—*Audrey G. Morgan.*

PENHA GODOY D'ALAMBERT, J., and PEREIRA DA SILVA, C. Adenocarcinoma esquirroso da mama com metástases ósseas generalizadas. (Scirrhus adenocarcinoma of the breast with generalized bone metastases.) *Hospital*, Rio de Janeiro, May, 1944, 25, 715-727.

A case is described in a woman of forty-three admitted to the Juqueri Hospital, São Paulo, Brazil in October, 1942. About six months before she had had severe genital hemorrhage caused by chronic endometritis and was very anemic on admission. In addition to the hard tumor of the right breast found on clinical examination, which proved to be a scirrhus adenocarcinoma, roentgen examination showed generalized bone metastases. The bone lesions progressed steadily until finally the external wall of the frontal bone was eroded. During the latter days of her life the right eye protruded and was sightless. She died July 9, 1943. Autopsy showed metastases also in the meninges, brain, kidneys, spleen, retroperitoneal lymph glands, pleura, pericardium and right eyeball.

The authors review the literature of this subject and also that of other forms of tumor that commonly cause bone metastases, such as tumors of the prostate and thyroid and hypernephroma. Cases like the one described are very rare and the authors believe that the bone metastases may have been initiated by the anemia which the patient had in the beginning and which produced a site of least resistance in the bone marrow. They study the frequency of bone metastases in general and consider the circulatory and biophysical factors which may be involved in their localization.—*Audrey G. Morgan.*

ADAIR, FRANK E. CRAVER, LLOYD F., and HERRMANN, JULIAN B. Hodgkin's disease of the breast. *Surg., Gynec. & Obst.*, Feb., 1945, 80, 205-210.

A noteworthy contribution to the understanding and treatment of Hodgkin's disease in recent years has been the recognition of primary

localized types. Gilbert in 1939 stated that "primary digestive, pulmonary, and bony lesions without involvement of the peripheral nodes are known." There is evidence that the disease in this form is amenable to surgery in some locations. Slaughter has reported good results with this mode of therapy in cases in which the disease was apparently confined to localized lymph node groups. Recently Bini has reviewed the literature on primary gastrointestinal lymphogranuloma. The results in many of those patients treated by surgery were encouraging.

Hodgkin's disease is most uncommon. Symmers, for example, gives its incidence as 0.04 per cent of the approximately 50,000 annual admissions to Bellevue Hospital. An unusual manifestation of this disease is involvement of the breast. A review of the literature discloses only 8 reported cases.

During the period of 1932 to 1942, 406 patients with Hodgkin's disease were seen at Memorial Hospital, New York. Among this group there were 5 individuals, or 1.25 per cent, who exhibited specific breast lesions of Hodgkin's disease. Within the same time interval 3,901 cases of carcinoma of the breast were seen.

A study of these patients with Hodgkin's disease of the breast as well as those reported in the literature reveals that:

1. The average age was 22.5 years.
2. The tumor was situated in the right breast in 8 cases and in the left in three.
3. There was 1 male in the series and 1 negro (female), the latter fact being noteworthy since Symmers and others have remarked on the rarity of the disease in this race.
4. Hodgkin's disease of the breast may manifest itself as a primary condition or as a lesion secondary to generalized lymphogranulomatosis. On that basis the following classification of lymphogranuloma of the breast is proposed: (1) primary; (2) secondary including (a) discrete and (b) diffuse.
5. Since the mode of spread of this disease is not well understood the condition may be considered primary in the breast only if there is no other evidence of the disease elsewhere in the body.
6. The importance of establishing a diagnosis of primary mammary lymphogranuloma lies in the fact that this condition may be amenable to surgical treatment.
7. Hodgkin's disease tends to infiltrate the

structures in the vicinity of the original lesion. Desjardins writes, "In some cases lymphoblastoma has a tendency to infiltrate the tissues outside of the lymph nodes and become quite extensive. Thus an entire breast and the superficial tissues of the corresponding half of the thorax may become densely infiltrated." If the axillary nodes are involved the disease is almost certainly generalized and, consequently, unsuitable for surgery.

8. Of the 4 examples of primary breast involvement in this collected series only 3 were followed until death, and of these, 2 were from the authors' clinic. The average duration of life after the onset of the disease in these 3 patients was four years and one month. In the 2 cases of secondary discrete involvement in the series the life duration of the patients after the initial appearance of the disease averaged five years and five months. The life expectancy in Hodgkin's disease is about two years and eight months. Thus it is seen that in the cases being discussed there was a definite increase in the life expectancy of the individuals with either primary or secondary breast involvement.

9. It may be that there is an increased life expectation in those cases that develop breast lesions. In primary involvement the explanation for this relative longevity may be that the disease remains localized in the breast for a considerable period before it appears in other locations. In the instances of secondary disease the explanation may be that the involvement of the breast under these circumstances is a late manifestation which occurs in the relatively long lived cases. In this it may be comparable to the abdominal manifestation of Hodgkin's disease which has been found to be a development late in the course of the disease, and a phenomenon occurring in those patients with relative longevity.

10. Students of the subject have been at a loss for an adequate explanation of breast involvement in the lymphomas. Symmers believes that lymphoid tissue must be present to act as a nidus. The authors are in agreement with this concept. The breast is adequately supplied with intralobular and periductal lymphoid infiltrates and some lymph nodes. These may be the foci for the localization of the lymphomas in this organ.—*Mary Frances Vastine.*

NELSON, W. E., and SMITH, L. W. Generalized obstructive emphysema in infants. *J. Pediat.*, Jan., 1945, 26, 36-55.

An expiratory type of dyspnea associated with generalized emphysema is common in infancy and childhood. Many varied etiological agents can produce a common picture. The obstruction is mainly in the terminal bronchioles. Obstruction to expiration which is usually more marked than obstruction to inspiration leads to emphysema. Complete obstruction leads to atelectasis. The picture clinically may resemble an attack of asthma but in obstructive emphysema the dyspnea persists for a week or more. Features which are common to all cases, no matter what the etiology, are an increased respiratory rate, decreased respiratory excursions, utilization of the accessory muscles of respiration with suprasternal retraction, varying degrees of cyanosis, hyperresonant percussion note, and characteristic roentgen findings.

On the roentgenograms the diaphragms are depressed and flattened, the intercostal spaces are widened, the lung fields are hyperaerated but of even greater value is the fluoroscopic picture of depressed, relatively immobile diaphragms and the relatively constant degree of aeration of the lungs in both inspiration and expiration.

In the authors' experience the above picture of obstructive emphysema is usually seen in a self-limited entity similar to the virus or atypical pneumonia of adults, but it may be seen in a variety of other conditions. Among these are aspiration of amniotic contents during birth, cystic fibrosis of the pancreas, atypical, bronchopneumonia, laryngotracheobronchitis, miliary tuberculosis, aspiration of zinc stearate powder, and chronic passive congestion secondary to congenital heart disease. Nelson and Smith present illustrative cases of obstructive emphysema resulting from each of these conditions. In some instances the obstruction is due to aspiration of foreign material and in others to edema and exudation from mucosal irritation.

The initial obstruction is probably of the "by-pass valve" type which permits free passage of air in both directions but this later changes to the "check-valve" type in which air enters the lungs freely but is then trapped and obstructive emphysema results. Should the obstruction become complete, the "stop-valve" type, atelectasis results.

In the differential diagnosis of conditions causing obstructive emphysema the age may be of help. If the symptoms are due to aspiration of

amniotic fluid they should be present at or shortly after birth. Symptoms associated with cystic fibrosis of the pancreas appear during the first weeks of life. Acute infections are more apt to occur after the child has left the nursery.

For treatment of obstructive emphysema associated with aspiration of amniotic fluid the authors suggest bronchoscopic aspiration or intratracheal aspiration by a catheter passed through a laryngoscope. Oxygen and carbon dioxide inhalations are also of value.—R. M. Harvey.

FABER, H. K., HOPE, J. W., and ROBINSON, F. L. Chronic stridor in early life due to persistent right aortic arch. *J. Pediat.*, Feb., 1945, 26, 128-137.

Most physicians are not aware that persistent right aortic arch can be a cause of chronic stridor in infancy and childhood. The diagnosis has been made more frequently since the publication of the paper of Assmann in 1924. The authors were able to find only 4 cases reported in the literature which were diagnosed during life in infants. They wish to emphasize the fact that the diagnosis was not suspected in any of the 4 although stridor was a predominant symptom. They present 2 cases of their own.

The first patient was a two months old white male admitted to the hospital for noisy breathing which had been present since birth. The noise was more conspicuous when the child was awake and crying. Laryngoscopy was negative. The correct diagnosis was not made on this admission but on a subsequent admission one year later, following a roentgen diagnosis of a mid-line thoracic tumor mass. Fluoroscopic examination showed an upper mediastinal shadow to the right of the spine with definite pulsations. No aortic knob was visible to the left of the spine. An esophagogram showed anterior and left-sided displacement of the esophagus at the level of the 4th and 5th thoracic vertebrae. A diagnosis of right aortic arch was made. The shadow of the descending aorta could be seen passing to the right of the spine.

In the second case, a two and a half year old male child, additional confirmation of the diagnosis was provided by kymographic studies, which showed vigorous pulsations in the right upper mediastinum and absence of pulsations on the left.

Dysphagia and stridor in these cases is due to compression of the esophagus by the right aortic arch, passing behind the esophagus on its

way toward the descending aorta. Symptoms may be absent or the stridor may be so severe as to cause retraction of the suprasternal notch, rib cage and epigastrium and cyanosis.

The diagnosis during life is by roentgen examination alone. The characteristic roentgen findings are anterior displacement of the esophagus at the level of the bifurcation of the trachea, a filling defect in the esophagus in the anterior view and left-sided displacement of the esophagus. The aortic knob is absent on the left and may be prominent on the right. The authors emphasize the value of the kymogram. Ordinary physical examination is practically worthless.

In the differential diagnosis mediastinal tumor, aortic aneurysm and thymic tumors must be considered. Probably many cases of stridor which have been diagnosed in the past as due to thymic hyperplasia have actually been due to right aortic arch. The latter diagnosis should be excluded before the former is considered. The condition of right-sided aortic arch is compatible with long living but respiratory infections must be guarded against.—*R. M. Harvey.*

LAVENSTEIN, A. F. Ingestion of kerosene complicated by pneumonia, pneumothorax, pneumopericardium, and subcutaneous emphysema. *J. Pediat.*, April, 1945, 26, 395-400.

There have been frequent reports on the accidental ingestion of kerosene by children. The seriousness of kerosene ingestion results from the associated pulmonary complications which have been proved to be due to aspiration of kerosene either directly or from regurgitation from the stomach into the lungs. The author reports a case of pneumonia, pneumothorax, pneumopericardium and subcutaneous emphysema following kerosene ingestion.

Lavenstein's patient was a two year old Negress who was admitted to the hospital after swallowing an unknown quantity of kerosene. Physical examination revealed a toxic child whose heart and lungs appeared essentially normal. She showed moderate acidosis and dehydration which was combatted with intravenous sodium lactate and 5 per cent glucose in normal salt solution. Two days following admission the child became dyspneic, her respirations rose to 88 per minute and she appeared extremely ill. Physical examination at this time showed an inpaired percussion note at the right base, coarse râles over the

right lung and crepitation over the anterior chest wall and supraclavicular areas.

Roentgen examination showed density at the right base due to consolidation or atelectasis, "stringy" infiltration throughout the remaining lung fields and subcutaneous emphysema. Roentgenoscopy later the same day showed bilateral pneumothoraces, mediastinal emphysema, and pneumopericardium. Following administration of oxygen and sulfonamides the patient made a gradual recovery.

The author offers the following explanation for the development of the pneumothorax, mediastinal emphysema, pneumopericardium and subcutaneous emphysema. Kerosene aspiration is followed by a diffuse pneumonitis associated with areas of bronchopneumonia or atelectasis. Surrounding these are areas of compensatory emphysema. This leads to ruptured alveoli from over-distention and escape of air through the perivascular sheaths into the mediastinum, thence into the pleural cavity, and by way of the fascial planes into the subcutaneous tissues of the neck.—*R. M. Harvey.*

KASSOWITZ, K. E. Healed asymptomatic miliary tuberculosis. *J. Pediat.*, Jan., 1945, 26, 56-60.

Before the advent of the roentgen ray, miliary tuberculosis was regarded as an almost invariably fatal disease. Recently subclinical and practically asymptomatic cases have been reported with evenly disseminated miliary tubercles throughout both lungs. Leiberman classified benign miliary tuberculosis in three groups: (1) cases having an early benign course but later dying of the disease; (2) cases in which complete clearing of the lung occurs, and (3) cases in which demonstrable miliary tuberculosis persists in the lungs.

The author reports a case of a child born in 1931 with a family history negative for tuberculosis. He was negative to 0.1 mg. of old tuberculin at the age of thirteen months. The child was not seen again until the age of eight when he had meningitic involvement with an upper respiratory infection. He made a complete recovery and following this attack showed a 1 plus reaction to 0.01 mg. of old tuberculin. A chest roentgenogram at this time showed a questionable soft calcification in the left hilum but was otherwise negative. Routine chest roentgenograms were negative until October, 1941, thirteen months after his last previous check-up at which time a chest roentgenogram

showed bilateral tracheobronchial adenitis, with dense calcifications, and miliary calcified nodules evenly distributed throughout both lung fields. The patient had been in good health in the interim since his last visit. Stomach washings inoculated into a guinea pig did not produce tuberculosis in the pig. Subsequent chest examination showed no change in the chest roentgenograms and the child remained asymptomatic for two and a half years after the original chest film showing miliary lung nodules. Roentgenograms are reproduced to show the sequence of changes.

In the differential diagnosis tuberculoid pneumoconiosis, lymphosarcomatosis, coccidiosis and other fungoid conditions must be considered.—*R. M. Harvey.*

HARDY, J. B., and KENDIG, E. L., JR. Tuberculous pleurisy with effusion in infancy. *J. Pediat.*, Feb., 1945, 26, 138-148.

A study was made of a group of 393 children under the age of two years infected with tuberculosis, at the Tuberculosis Clinic of the Harriet Lane Hospital. Thirteen, or 3.3 per cent, of this group had a tuberculous pleurisy with effusion. Diagnostic criteria were: (1) demonstration of tubercle bacilli by culture or guinea pig inoculation of the pleural fluid; (2) calcification in the pleura after disappearance of the fluid, or (3) a positive tuberculin test, the presence of pleurisy with effusion, and the subsequent course of the disease. Thirty-two other children in this series had a demonstrable fibrinous pleurisy by roentgen examination.

The age incidence for the development of the effusion varied from ten to twenty-eight months. The effusions were almost three times as common in colored children as compared with white. All of the children had a demonstrable underlying tuberculous process; 7 a primary complex, all of whom made an uneventful recovery, and 6 had mediastinal tuberculosis complicated by tuberculous pneumonia. Two of the latter group developed cavitation and required pneumothoraces. The majority of the effusions lasted less than six months. Eight of the 13 cases recovered with calcification of the primary complex, 2 developed the adult type of tuberculosis, 1 dying of renal tuberculosis years later, and the other 3 died of tuberculous meningitis. All of the deaths were in Negro patients. Eleven of the cases had a known exposure to sputum positive tuberculosis.

The thirteen cases are summarized and roentgenograms of 9 of the cases are reproduced.—*R. M. Harvey.*

NEUHOF, HAROLD. Acute putrid abscess of the lung. *Surg., Gynec. & Obst.*, April, 1945, 80, 351-354.

This paper is based on the 172 cases of acute putrid abscess of the lung which have been subjected to operation in the past sixteen years, at the Mount Sinai Hospital, New York.

Pathology of Acute Putrid Pulmonary Abscess.

1. Omitting the rare metastatic form all putrid pulmonary abscesses can be assumed to be due to aspiration of infective material. There is set up a gangrenous bronchopneumonia in the involved bronchopulmonary segment.

2. Liquefaction occurs in a few days and an abscess is formed within a week or ten days of the onset of the pulmonary infection. The abscess is usually fully developed within two weeks.

3. The abscess is single and spherical, is always situated superficially within the pulmonary lobe, and abuts on the thoracic parietes.

4. The abscess cavity is well demarcated from the beginning. Its contents are foul air, pus, and debris, and, in the early stages, fragments of gangrenous lung. The interior of the cavity is smooth at a surprisingly early stage. The orifices of one or more bronchi are present.

5. Well defined pleural adhesions are present over the abscess which usually seal off effectively the free pleural space. These adhesions are visceroparietal in the great majority of cases, bind the abscess to the thoracic parietes, and render it readily accessible for safe surgical entry. In a small proportion of cases the abscess faces a fissure, the diaphragm, the mediastinum, or the pericardium.

Classification. Toward the end of, or after, six weeks, additional lesions usually appear; multi-ocularity, spread of infection by spill-over, interstitial pneumonitis, fibrosis, bronchiectasis. Accordingly it was decided to term all abscess *acute* if of less than six weeks' duration and *chronic* if over the age.

Indications for Operation. (1) Imperative—patients with hyperacute manifestations (severe toxicity), unusually large abscesses which appear to be on the verge of invading or have already invaded the pleura. (2) Elective—cases of small abscesses which remain stationary or increase in size after a period of observation,

abscesses in which cavities drain poorly (roentgen evidence), patients with sustained fever or intensely fetid sputum, cases in which there is diabetes.

Roentgenologic Applications.

1. The application of roentgenology to the diagnosis and especially to the exact localization of an acute abscess represents the essential basis for correct surgical management.

2. After it was learned that films revealed the characteristic feature of pulmonary abscess (cavity with a fluid level) in no more than half the cases, that only a circumscribed area of dense "pneumonic" infiltration existed in some cases, and that areas of rarefaction might or might not appear in the midst of such infiltration during observation, it became evident that the diagnosis of pulmonary abscess often could not be made on films alone. On the other hand, studies of films always made possible a precise localization of the abscess.

3. In order to have precise localization, a mixture of methylene blue and iodized oil is injected into the intercostal musculature at the assumed place (often determined fluoroscopically) of contact between the abscess and the thoracic wall. Films in appropriate positions are taken and the relationship of the iodized oil to the abscess is seen. The methylene blue in the musculature is exposed at operation in order to locate the situation of the radiopaque oil which was injected.

Operative Procedure. The development of the one stage operative procedure was based on the realization that a pulmonary abscess is characterized by a superficial position with overlying adhesions and that the essential pathology is constant. Thus, when adhesions are not encountered one can be quite sure that the site of surgical approach is not correct.

In brief, this procedure consists in exposure of pleural adhesions by a limited excision of a segment of the rib, incision through adhesions at their densest portion, disclosure of the abscess by aspiration, its uprooting by excision of the thin compressed shell of overlying lung, and the visualization and gauze tamponade of the abscess cavity and all its recesses.—*Mary Frances Vastine.*

REES-JONES, G. F. Cystic disease in an azygos lobe with phrenic nerve paresis. *Brit. J. Radiol.*, Dec., 1944, 17, 386.

An airman of twenty-four complained of

general debility and dry cough. A roentgenogram showed an azygos lobe and fluoroscopy showed that about two-thirds of the right diaphragm was paralyzed. Tomography showed that the azygos lobe was made up almost entirely of cysts. There was no evidence that they were infected as the patient had no sputum. Bronchography showed the cysts well filled. Shortly after this examination the patient coughed up a considerable amount of sputum, which was not examined.

The paresis of the phrenic nerve was probably due to the fact that the nerve in its passage through the upper thorax was involved in the same anomaly of development that caused the infolding of the pleura that produced the azygos lobe. The bronchus to the lobe was stenotic, which was probably the cause of the cysts.—*Audrey G. Morgan.*

GUYER, R. B. Case of bronchial carcinoma presenting diagnostic difficulties. *Brit. J. Radiol.*, Dec., 1944, 17, 380-382.

A soldier forty-one years of age was sent for examination complaining of loss of weight and persistent cough. Roentgen examination showed a dense opacity in the right apex just below the clavicle which suggested tuberculosis. A swelling of the 8th left rib should have suggested the true condition but a biopsy later was diagnosed as sarcoma. He was given roentgen treatment and the swelling on the rib completely disappeared. When he returned some weeks later the 3d lumbar vertebra had been destroyed and the patient's general condition had deteriorated rapidly. Roentgen examination showed massive consolidation of the upper right lung and a diagnosis of bronchogenic carcinoma was made. The course of the disease was rapid and the patient died in a little more than three months after his first admission to hospital.

Autopsy showed a small tumor originating from the eparterial bronchus. Histopathological examination showed that it had developed from the bronchial epithelium which had undergone metaplasia to a stratified type. The tumor was a very malignant anaplastic epithelioma.—*Audrey G. Morgan.*

LAFF, HERMAN I., and NEUBUERGER, KARL T. Bronchial adenoma with metastasis. *Arch. Otolaryng.*, Dec. 1944, 40, 487-493.

The authors report 2 cases of so-called bronchial adenoma in which the neoplasm presented

different histologic patterns. In one the rare cylindromatous form existed for thirteen and a half years and terminated with metastasis to the opposite lung. In the second the more common solid form of the neoplasm was at first mistaken for "oat cell carcinoma." Correlated clinical and pathologic studies may serve to confirm the impression that the cylindromatous form is potentially more malignant than the more common form. The term "bronchial carcinoid"—already employed by some authors—might be adopted in preference to "bronchial adenoma."

Diagnosis and Treatment. Bronchial adenoma is commonly found in one of the main bronchi, is slow growing and produces severe cough, pain in the chest, wheezing dyspnea and frequently severe hemoptyses. Prolonged bronchial obstruction ultimately causes extensive damage to the lung distal to the stenosis, resulting in atelectasis, drowned lung, pneumonitis, bronchiectasis, pulmonary abscess and empyema.

Endoscopic treatment may result in cure when the neoplasm exists only as a pedunculated polyp. This rarely occurs; in most instances bronchial adenoma is sessile and has extrabronchial extensions, frequently larger than the endobronchial portions.

It appears that total eradication is dependent on intrathoracic surgical intervention (lobectomy or pneumonectomy). Many apparently permanent cures have been effected in these cases.

In contrast to the age incidence of the more common bronchogenic carcinoma, the adenoma endangers chiefly the female sex and the younger age groups, between twenty and fifty years.

Pathogenesis. The authors wish to stress the potentially malignant character of neoplasms diagnosed as bronchial adenoma, manifested in their invasive growth (extrabronchial extension) and their ability to produce late metastases. Their histologically "benign" appearance is not incompatible with biologically malignant behavior.—*Mary Frances Vastine.*

TAYLOR, HENRY K., and MCGOVERN, TERESA. Angiocardiography; anatomy of the heart in health and disease. *Radiology*, Oct., 1944, 43, 364-372.

Angiocardiography has helped to settle many problems in regard to the anatomy and pathology of the heart since it was first introduced

by Robb and Weiss in 1928. The authors have studied 120 cases by this method, 18 of them normal and the others showing various kinds and degrees of abnormality. Cardiograms and diagrammatic sketches of normal and various pathological conditions are given. They found that the normal heart outline differs somewhat from that usually described. Detailed descriptions of the appearance in the various positions are given. This method is of value in studying congenital anomalies of the heart and great vessels and makes it possible to differentiate between vascular and non-vascular lesions of the mediastinum. The middle segment of the heart is formed in the majority of cases by the left pulmonary artery. Less frequently it is formed by the pulmonary aorta and occasionally by both. The descending aorta may also form a part of the border of the middle segment of the heart. The ventricular conus lies deep, within the heart shadow and never forms a part of the border.

In the posteroanterior position the right heart does not occupy more than half the silhouette of the heart. The ascending aorta normally does not form part of the right border of the heart which is made up of the superior vena cava and the right auricle, with the inferior vena cava taking part sometimes in the formation of the lowermost part. In the right anterior oblique position the left auricle and ventricle form a figure 8, lying in an almost horizontal plane, with the auricular shadow posterior to and on a slightly higher level than that of the left. The left ventricle occupies the greater part of the heart outline and helps form the border anteriorly.

Two non-opacified areas were seen in the heart outline. The one at the lower part of the heart outline in the posteroanterior position is believed to be the inferior vena cava while the one at the junction of the middle heart segment and the base of the left ventricle is thought to be a solid part of the left auricular appendage.—*Audrey G. Morgan.*

MAYO, OSCAR N., and SPENCER, JACK. Cardiospasm. *Radiology*, Oct. 1944, 43, 383-385.

Cardiospasm can usually be diagnosed clinically from the epigastric pain or discomfort, dysphagia and regurgitation of food. But sometimes clinical symptoms are so slight that diagnosis cannot be made without roentgen examination.

Such a case is reported in a Negro twenty-six

years of age admitted to the Station Hospital, Fort Bliss, Texas, for gonorrhea but also complaining of an acute upper respiratory infection which he had had for four days. For this reason pneumonia was suspected and a roentgen examination made. It showed changes in the right lower lung field which were thought to be those of pneumonia, and a mass in the mediastinum which extended toward the right. Roentgenoscopic examination with barium showed a dilated esophagus with obstruction at the cardia, which established the diagnosis of cardiospasm. Inhalation of amyl nitrite relaxed the cardia partially and some of the barium passed into the stomach. This is an important differential sign from carcinoma, in which the cardia does not relax. Later examination showed that the focus in the lower lung field was an aspiration pneumonitis from having aspirated some of the overflowing contents of the esophagus.

It is very necessary in obscure conditions in the chest to make a roentgen examination with the esophagus filled with barium.—*Audrey G. Morgan.*

ABDOMEN

VAUGHAN, W. W., and EICHWALD, MAX. Priodax; contrast medium for cholecystography. *Radiology*, Dec., 1944, 43, 578-581.

Priodax has been found a useful contrast medium in cholecystography and superior in some respects to tetraiodophenolphthalein. It is freer from by-effects such as nausea, diarrhea and vomiting and the gallbladder is not obscured by the presence of the medium in the region of the hepatic flexure of the colon as it often is on the use of tetraiodophenolphthalein.

The authors discuss the use of priodax in 163 unselected cases. The drug was given by the double dose, the divided dose and the single dose methods. The latter was found preferable and is now used as a matter of routine.

A series of 63 cases was analyzed for operative confirmation of roentgen findings. Thirty-nine were normal and 24 showed evidence of gallbladder disease. In 22 of the latter cases the cholecystographic findings were confirmed by operation.—*Audrey G. Morgan.*

JOHNSTONE, A. S. Stellate translucencies as a sign of gall-stones. *Brit. J. Radiol.*, Nov., 1944, 17, 352-353.

A case is described in a woman of twenty-eight who had symptoms of gallstones. The roentgenogram of the gallbladder region showed

a number of slight translucencies surrounded by faint calcified margins and shaped like faceted gallstones. In the center of each there was a sharp stellate translucency. Operation showed multiple gallstones.

This condition is very rare. This is the first case recorded in about 6,000 cholecystographies. The central fissuring of gallstones which must take place before air can be admitted to their interior is probably caused by shrinking of the albuminoid matrix of the soft center. The outer walls are rigid and do not give so that a central cavity is formed.—*Audrey G. Morgan.*

SCOTT, VIRGIL. Abdominal aneurysms. *Am. J. Syph., Gonorr. & Ven. Dis.*, Nov., 1944, 28, 682-710.

In a review of 96 patients with abdominal aneurysms from the records of the Johns Hopkins Hospital, Scott found 58.3 per cent to be syphilitic, 20 per cent arteriosclerotic, 18.8 per cent mycotic, 1 per cent due to periarteritis nodosa and 1 per cent tuberculous (contiguous infection). There is a wide variation in the distribution of the etiological agents in comparative studies from various centers. Syphilis has been reported as the cause of abdominal aneurysm from as low as 8.8 per cent to as high as 75 per cent. Syphilitic aneurysms occurred chiefly in the upper abdominal aorta, 80 per cent were above the renal artery and all the arteriosclerotic aneurysms were in the lower aorta or beyond the bifurcation. Mycotic aneurysms occurred chiefly in the smaller abdominal vessels as the mesenteric or hepatic artery. Multiple aneurysms occurred in 14.4 per cent of the syphilitic group, 30 per cent of the arteriosclerotic group and in 16.5 per cent of the mycotic group. Seventy-five per cent of the syphilitic aneurysms occurred under fifty years of age while arteriosclerotic aneurysms were found in the older age groups predominantly. Because of the relation to bacterial endocarditis, the peak incidence of mycotic aneurysms was in the lowest age group. About two-thirds of the abdominal aneurysms were in Negroes, 89 per cent were in males. Arteriosclerotic aneurysms were found in white patients only. Pain is the outstanding symptom which with bone erosion is quite severe at night. Nausea and paresthesias may occur. The majority of arteriosclerotic aneurysms were symptomless. In 75 per cent of the syphilitic group an expansile pulsation was detected whereas mass was present in only 25 per cent of the arterio-

sclerotic group of which but 2 of 5 revealed pulsation. A mass in relation to a large vessel or a very vascular tumor may produce the effect of pulsation which may be mistaken for aneurysm. The syphilitic aneurysms were the largest of the three main types. Saccular lesions predominated in each group, the highest percentage of fusiform or diffuse aneurysms occurred in the arteriosclerotic group. A high incidence of involvement of the heart and aorta was present in the syphilitic group contrary to teaching. Rupture occurred earlier in the mycotic group due to necrosis. The demonstration of calcification in the wall of an aneurysm together with bone erosion, usually between the 11th thoracic body and the 2nd lumbar body is diagnostic. The prognosis is grave but may be variable, one patient surviving twenty-eight years.—*Leo A. Nash.*

BROWN, SAMUEL, FLACHS, KAMILLO, and WASERMAN, PHILIP. Aberrant pancreatic tumor in the duodenal wall. *Radiology*, Oct., 1944, 43, 385-386.

Aberrant pancreatic tissue rarely causes tumor but when it does the tumor is usually in the duodenum. Such a case is described in a woman of sixty-four admitted to the Department of Roentgenology of the Jewish Hospital, Cincinnati, complaining of pain in the abdomen, loss of appetite, "sour stomach" and frequent vomiting for two months. A complete roentgen examination of the gastrointestinal tract was made. The gallbladder failed to fill and there were no dense shadows suggestive of gallstones. The stomach and bulb of the duodenum were normal in size and shape. In the right lateral position they were found in normal position with relation to the surrounding structures but the duodenum contained gas with only a little of the contrast mixture irregularly distributed through it. Most of the barium had been vomited shortly after the examination. There was no obstruction or deformity in the colon. A probable diagnosis of lesion of the gallbladder was made.

Re-examination ten days later showed uniform filling of the gallbladder of only moderate density. But in the right lumbar region was a large oval pocket containing gas, apparently in the duodenum. A second barium meal examination showed the stomach normal in size but the duodenum greatly dilated and ending abruptly at the inferior angle. In the right lateral position there was a deformity in the

outline of the ascending part of the duodenum which encroached on its lumen and apparently caused stenosis. A diagnosis of new growth in the duodenum was made. This diagnosis was confirmed on operation and microscopic examination showed that the tumor originated from pancreatic tissue. As there was no tumor in the pancreas itself it was concluded that the tumor originated from aberrant pancreatic tissue in the wall of the duodenum.—*Audrey G. Morgan.*

JACOBS, E. A., CULVER, G. J., and KOENIG, E. C. Roentgenologic aspects of retroperitoneal perforations of the duodenum. *Radiology*, Dec., 1944, 43, 563-571.

Perforations of the duodenum into the free peritoneal cavity are easily diagnosed and treated but in retroperitoneal perforation the mortality still remains at 90 per cent. These perforations may result from peptic ulcer but are usually caused by injuries such as kicks or blows on the abdomen, crushing between heavy objects or being run over by a vehicle. Clinical symptoms do not usually appear until extravasation has occurred and it is then too late for treatment. Infection has occurred and death results from retroperitoneal cellulitis and necrosis.

It should be easy, however, to make a diagnosis by roentgen examination within an hour or two of the injury. In spite of this fact, however, roentgen diagnosis has been reported previously in only 3 cases. The use of barium or bismuth salts is contraindicated in perforations of the gastrointestinal tract but the air passing through the rupture in the intestine produces an emphysema which can be demonstrated roentgenologically. A chart is given showing the routes usually followed by air passing through a retroperitoneal rupture of the duodenum.

Proper positioning of the patient is absolutely necessary in examining for this condition. Roentgenograms of the abdomen should be made with the patient in the supine, the upright, left lateral decubitus and lateral positions. Stereoscopic roentgenograms may help in localizing the emphysema. The patient should be told to lie on his left side so that air rather than intestinal contents will pass through the opening.

Two cases of traumatic retroperitoneal perforation of the duodenum are described and illustrated with roentgenograms. In both cases

the trauma was the result of a blow on the back, not the abdomen. The roentgenogram was negative in the first case because of the absence of emphysema but the condition was demonstrated on autopsy. In the second case, the patient recovered without surgery so the nature of the lesion was not absolutely proved but the roentgenographic evidence was quite conclusive.—*Audrey G. Morgan.*

POMERANZ, RAPHAEL, GRADY, HUGH G., PEELEN, MATTHEW, and MAGNES, MAX. Spontaneous cholecystoduodenal fistula in a patient with primary hepatoma of the liver. *Radiology*, Dec., 1944, 43, 582-587.

A corporal, forty-two years of age, a native of South America, was admitted to Winter General Hospital, Topeka, Kansas, on October 15, 1943, by transfer from a station hospital which he had entered a month previously complaining of persistent dull epigastric pain. He had a feeling of obstruction in the stomach but no vomiting. No history of tarry or clay-colored stools. In 1938 he had had an attack of severe epigastric pain which was relieved by an injection and he had been well since up to the time of his admission to the hospital. He had chills alternating with fever. Tentative diagnosis based on roentgen examination September 25, diffuse gastric carcinoma or syphilis of the stomach.

On admission to the Winter Hospital there was rigidity of the upper part of the right rectus muscle and a tender mass below the xiphoid process on both sides. Red blood cells 4,300,000, white cells 10,000, hemoglobin 13.8 gm. Occult blood in the feces, total gastric acidity 49.0, free hydrochloric acid 45.0, no lactic acid. Roentgen examination showed a spontaneous fistula between the upper part of the duodenum and the gallbladder; there was a possible obstructive stone in the cystic duct. The liver was enlarged about 2 inches below the costal margin.

Operation showed multiple nodules of the liver, microscopic examination of which proved adenocarcinoma of the liver. Both lobes of the liver were adherent to the diaphragm, and the lesser curvature of the stomach was adherent to the lower surface of the left lobe of the liver.

Autopsy showed the lower two-thirds of the left lobe of the liver and the median part of the right lobe replaced by a solid mass of tumor tissue while there were tumor nodules throughout the rest of the liver. There was a single cal-

culus in the gallbladder and one in the common duct. There was secondary adenocarcinoma of both adrenals and degeneration of the myocardium.

The incidence of spontaneous biliary fistulae is about 0.4 per cent; they are generally caused by chronic gallbladder disease, as in this case. The spontaneous biliary fistula evidently preceded the tumor of the liver; it is not known how much the chronic infection of the gallbladder contributed to the development of the carcinoma of the liver; probably the two processes were independent. Microscopic examination showed no cirrhosis, which is associated with 85 per cent of hepatomas. The incidence of primary carcinoma of the liver is also low, probably about 0.2 per cent and the association of these two unusual conditions is extremely rare. The authors have not found any other case reported in the literature.

The carcinoma of the liver was only suspected clinically but there was one roentgen sign that should have suggested it, namely a "selective" barium residue at the lesser curvature of the fundus of the stomach near the left lobe of the liver.—*Audrey G. Morgan.*

SHIRLEY, AMOS R. An unusual gastrocolic communication. *Radiology*, Dec., 1944, 43, 588-590.

A white man forty-eight years of age who had been well previously had an attack of vomiting following a heavy meal with severe pain and slight distention of the abdomen. He appeared undernourished and underweight but said he had lost no weight before the attack two weeks previously. Roentgen examination of the digestive tract showed an unusual communication between the stomach and colon about 11 cm. long lying in the left half of the abdomen. The upper part of the tract was triangular and measured 7 cm. across and 4 cm. in depth. The rest of the tract which passed into the transverse colon had a maximum width of about 3.5 cm. It seemed possible that the triangular part of the tract was a part of the stomach separated from the rest of the organ by a carcinoma. There was no palpable mass such as would be expected from a large carcinoma but there was firmness on pressure over the abdomen. No part of the communicating tract showed a mucosal pattern like that of the stomach, small intestine or colon.

On the forty-eight hour roentgenogram the deposition of barium in the tract was the same

as that in the stomach, supporting the theory that at least the upper triangular part of the tract was a part of the stomach. This was confirmed on operation. A tumor 10×12 cm. in diameter was found in the stomach, involving the greater curvature, the gastrocolic omentum and the middle part of the transverse colon. The gastrocolic fistula which had been demonstrated roentgenologically lay within this tumor. The appearance of segmentation in the roentgenogram had been caused by a broad, ring-like band of carcinomatous tissue running parallel to the curvature. Inside it lay that section of the communicating tract which connected the large upper part of the stomach with the smaller and lower triangular part.

The patient died the day of the operation one month after the first appearance of symptoms. As he had had no symptoms until two weeks before examination it is impossible to say how long the carcinoma had been developing. —*Audrey G. Morgan.*

BERSON, H. LEWIS, and BERGER, LOUIS. Multiple carcinomas of the large intestine. *Surg. Gynec. & Obst.*, Jan., 1945, 80, 75-84.

This investigation is limited to cancers in the colon and rectum as encountered during the years 1934 to 1943 inclusive. The summary and conclusions are:

Summary.

1. The presence of a carcinoma does not confer immunity against the appearance of other primary cancers in the large intestine.

2. A predisposition or susceptibility to cancer is more important in the multiple carcinomas than chance, age or sex.

3. Sixty-six cases of double and 6 patients with three cancers were collected from the literature since 1932. To these are added 13 patients with two cancers and 3 patients with three malignant growths.

4. Polyps were present in 25 per cent of single cancer patients and in 37.5 per cent of those with multiple carcinomas. In 67 per cent of the latter group, malignant degeneration had taken place.

5. The frequency of multiple cancers in our series was found to be 4.8 per cent.

6. There were 11 cases in men and 5 in women.

Conclusions.

1. Multiple cancers can occur in the large

intestine either synchronously or metachronously.

2. The prognosis in cancer resections is influenced by the presence of a second malignant lesion in that if overlooked death of the patient may ensue because of the continued growth of the lesion.

3. Any patient who has had one carcinoma removed should be observed carefully and repeatedly for the possible development of a second new growth. Grindley very aptly stated, "A patient with one cancer is a good subject for the development of a second, and is more susceptible than one who is cancer free." —*Mary Frances Vastine.*

FISHBACK, H. R., JR. Meckel's diverticulum strangulated in an inguinal hernia. *Harper Hosp. Bull.*, Dec., 1944, 2, 60-64.

From 1912 to the present time only 14 cases of strangulation of a Meckel's diverticulum in an inguinal hernia have been reported. The case described here is the fifteenth. A review of the literature and a bibliography of the subject are given.

The patient was a woman of forty-seven admitted to Harper Hospital August 23, 1944, complaining of anorexia, loss of weight and a "draining rupture" of three weeks' duration. She had been in good health until 1938 when she had a pelvic operation performed. When she left the hospital there was a small protruding mass in the perineum which she called a rupture. On August 7, 1944, the rupture broke through the skin in four places, three in the perineum and one to the right and above the right pubic tubercle. On several occasions after 1938 she had had blood in the stools.

Physical examination on admission showed transverse enlargement of the heart with systolic and diastolic murmurs over the mitral area and three draining sinuses in the perineum and one above the right pubic tubercle. She was put on soft diet and symptomatic treatment but became distended and cyanotic with a terminal rise of rectal temperature to 101° F. and she died on September 14, 1944.

Autopsy showed fluid in the abdominal and thoracic cavities. A mass protruded from the opening in the skin above the right pubic tubercle. Thirty-four inches from the ileocecal valve a Meckel's diverticulum had herniated into the inguinal canal and become strangulated. A diagrammatic drawing of the hernia and diverticulum is given. A growth on the

pulmonic valve proved to be an aseptic one superimposed on a hemangioma of the base of the valve.—*Audrey G. Morgan.*

GYNECOLOGY AND OBSTETRICS

BANNER, EDWARD A., HUNT, ARTHUR B., and DIXON, CLAUDE F. Pregnancy associated with carcinoma of the large intestine. *Surg. Gynec. & Obst.*, Feb., 1945, 80, 211-216.

Up until 1943, there have appeared in the literature a total of 62 cases in which carcinoma of the intestine has complicated pregnancy. This report adds 7 additional cases of pregnancy associated with carcinoma of the large bowel. The findings may be summarized as follows:

1. In the 62 cases encountered in the review of the literature, the maternal mortality was 63 per cent in the 41 cases in which the maternal outcome was known. The gross fetal mortality was 50 per cent in cases in which surgical treatment was employed.

2. The maternal mortality and the corrected fetal mortality were both 14.3 per cent in the 7 cases reported by the authors.

3. The age and weight of the patients as well as the concentration of hemoglobin in the blood and the sedimentation rate of the erythrocytes are of little value in arriving at a diagnosis of carcinoma of the intestinal tract in pregnancy.

4. Some symptoms of carcinoma of the colon or rectum, such as nausea, vomiting and constipation, are thought to be commonly associated with pregnancy. Proctoscopic and roentgenologic examination of the colon should be performed in all cases in which pregnant women complain of unexplained constipation, diarrhea, or bloody discharge from the lower part of the bowel. Nausea and vomiting, especially in the latter half of the pregnancy, demand the exclusion of carcinoma of the colon.

5. On reviewing the literature one is impressed by the ease with which delivery takes place through the pelvis even after removal of the lower part of the sigmoid colon and rectum.—*Mary Frances Vastine.*

LYNCH, ROBERT, and DOCKERTY, MALCOLM B. Spread of uterine and ovarian carcinoma with special reference to the role of the fallopian tube. *Surg., Gynec. & Obst.*, Jan., 1945, 80, 60-65.

This paper is based on a study of 113 cases of carcinoma of the uterus or ovary, or of both

of these organs, that were observed at the Mayo Clinic in eleven and one-half years, namely from January 1, 1929, to June 30, 1940, inclusive.

Anatomic studies have demonstrated the existence of interconnecting links in the lymphatic drainage of the uterus, tubes and ovaries. The inescapable conclusion from this study is that carcinoma may spread from the uterus to the ovaries, or vice versa. In the majority of cases the spread is by direct extension or by lymphatic extension or by lymphatic permeation alone or combined, and frequently, with simultaneous involvement of the fallopian tube as an intermediary stage in the process. In a minority of these cases viable malignant cells may spread through the lumen of the fallopian tube, usually without being implanted on its mucosa.

Summary.

1. In 113 cases of operative uterine and ovarian carcinoma the malignant process had invaded other pelvic structures.

2. In 51, or 44 per cent, of the cases the lesion arose in the ovary and involved the fallopian tube, and in 12 cases it arose primarily in the fundus of the uterus and involved a fallopian tube.

3. In 20, or 18 per cent, of the cases the lesion involved the ovaries, endometrium, and tubes. In 12 of these cases the primary site of the lesion was in the ovary, in 6 cases it was in the uterine fundus, and in 2 cases the primary site was doubtful.

4. In 30 cases ovarian and endometrial carcinoma coexisted without evidence of tubal lesion. The primary growth was uterine in 12 cases and ovarian in 13. In 5 cases the site of the primary lesion was doubtful and the possibility of two independent sites of origin could not be excluded entirely.

5. Approximately 6 per cent of ovarian carcinomas metastasized to the endometrium and examination of curetted material occasionally revealed the extrauterine site of the primary growth.

6. Conversely, about 4 per cent of operable carcinomas of the uterine fundus eventually involved the ovary or ovaries. In both circumstances the fallopian tube seemed to act as the intermediary host to the malignant cells. In only 1.4 per cent of cases did it serve in the capacity of a passive conduit, and in only 0.4 per cent was the direction of the flow reversed,

namely, from uterus to ovary. From a practical standpoint, therefore, little risk was indicated for the production of ovarian or abdominal implantation in curetting a uterus which is the site of a malignant lesion, prior to the insertion of radium. In only a few cases was evidence found that carcinoma cells became implanted on tubal mucosa in the extension of malignant lesions of the ovary or fundus of the uterus.—*Mary Frances Vastine.*

INGRAHAM, CLARENCE B., BLACK, WILLIAM C., and RUTLEDGE, ENID K. Relationship of granulosa-cell tumors of the ovary to endometrial carcinoma. *Am. J. Obst. & Gynec.*, Dec., 1944, 48, 760-773.

Granulosa and theca cell tumors may be associated with much excessive and abnormal endometrial hyperplasia that a histologic pattern indistinguishable from adenocarcinoma results. Two cases of granulosa cell tumor and one of theca cell tumor of the ovary associated with adenocarcinoma of the corpus uteri are reported by the authors.

In each of these cases the histologic appearance of the endometrium is sufficiently hyperplastic and atypical to be classed as adenocarcinoma.

Endometrial hyperplasia which duplicates the histologic features of adenocarcinoma of the uterine body may accompany granulosa cell tumors of the ovary. In the author's 1 case, the endocervix was also hyperplastic. There is no histologic criterion which enables one to distinguish this condition from adenocarcinoma, yet in one of Stohr's cases, that of a woman before the menopause, a normal menstrual cycle was resumed six weeks following the removal of the granulosa cell tumor. Curettage after eight weeks showed a typical early secretory phase of the endometrium, and the patient remained well with a normal menstrual history for five years. This case is remarkable in that only the ovarian tumor was removed. The estrogenic influence of the remaining ovary was not abolished and yet the endometrial hyperplasia regressed. This case provides evidence of the direct relationship between the ovarian tumor and the endometrial hyperplasia, considered by Stohr as adenocarcinoma, and in addition, indicates that such proliferation is reversible.

It remains a question as to whether or not a true carcinoma of the endometrium would regress if all abnormal sources of estrogenic hor-

mones could be removed. According to Taylor, three sources of an excessive supply or abnormal type of estrogenic hormone in the human may be considered: from follicles, as in follicular (functional) cysts; from ovarian tumors, as in granulosa cell and theca cell tumors; and from an extra-ovarian source. In the third instance, the presence of estrogenic substances in male urine and in the urine of females after the menopause and after castration may be cited. Extra-ovarian estrogenic substances may be formed in both sexes in the metabolism of cholesterol and bile acids and chemically related carcinogenic substances may likewise originate in the same manner.

From the report of Jones and Brewer, it appears that normally functioning ovaries do not prevent the development of endometrial carcinoma, and that hyperestrinism or the unopposed action of estrin is not responsible for such development. It is possible that all endometrial carcinomas do not have the same cause or causes.—*Mary Frances Vastine.*

MAINO, CHARLES R., BRODERS, ALBERT C., and MUSSEY, ROBERT D. Pathology of malignant neoplasm of the cervix coincident with pregnancy. *Am. J. Obst. & Gynec.*, Dec., 1944, 48, 806-823.

The 26 cases studied represented 0.7 per cent of 3,570 cases of malignant neoplasm in which the patients were admitted to the Mayo Clinic between 1909 and 1941. During this period, 8,500 pregnant women were given obstetric care but, since all of those whose pregnancy was complicated by cancer sought treatment primarily for the malignant condition rather than for obstetric care, the incidence of malignant lesions in this group of pregnant women cannot be estimated.

Of the entire group of 26 patients, in 24 instances a follow-up period of at least five years had elapsed in March, 1944; of these 24, eight were alive and free of recurrence five or more years after the diagnosis was made, a "cure" incidence of 33 per cent.

Twenty-five of the 26 patients had carcinoma of the cervix and 1 patient had myxosarcoma. Of the 25 cases of carcinoma, there were 19 cases of squamous cell epithelioma, 3 cases of adenocarcinoma, 1 case of mixed squamous cell epithelioma and adenocarcinoma, and 2 cases in which the type of carcinoma was not determined.

Bleeding was the primary symptom in nearly

90 per cent of the cases. Among patients in Stage I of the disease, the average duration of symptoms was nine months, as compared with three months for those in Stage IV. Grade 4 lesions were not more frequent in the more advanced cases than in the less advanced cases.

The extent or stage of the lesion corresponded in general to the duration or stage of pregnancy. Seventeen per cent of patients who had Stage I carcinoma, 33 per cent of those in Stage II, 50 per cent of those in Stage III, and 67 per cent of those in Stage IV had full term pregnancies. Five of 8 patients who lived five or more years had squamous cell epithelioma; 3 had adenocarcinoma. Of patients observed for five or more years, 4 of 6 patients who had Stage I carcinoma (66 per cent), 3 of 8 patients in Stage II (38 per cent), 1 patient in Stage III (17 per cent), and no patients in Stage IV, were alive five or more years after the malignant neoplasm of the cervix coincident with pregnancy was diagnosed.—*Mary Frances Vastine*.

REICH, WALTER J., and NECHTOW, MITCHELL J. Cystic pelvic chordoma simulating an ovarian cyst. *Am. J. Obst. & Gynec.*, Feb., 1945, 49, 265-268.

Chordoma is a tumor which originates in the remnants of the notochord. According to Delafield and Prudden, in man it is a transient, though important, embryologic structure which disappears early in fetal life except for traces remaining in the intervertebral discs (nucleus pulposus). Chordomas may occur anywhere along the spinal cord or develop from the sacrum and coccyx. Both benign and malignant growths have been described in the sacrum.

The morbid anatomy, according to the experiences of Stewart and Morin, varies. Clinically the degree of mucoid degeneration present in a chordoma is an index of its comparative benignancy, the formation of mucin being in inverse ratio to the rate of cellular activity. With increased malignancy, the tumor becomes more and more solid and opaque. One of the most striking features of the chordoma is its locally destructive effects on bone.

Chordoma is usually a tumor of low malignancy, slowly infiltrating and destructive; tends to recur after removal; exceptionally, it may metastasize.

Of the various cases reported by Stewart and Morin the age groups were as follows: 34.9 years in 20 cases of the spheno-occipital region; 50.6

years in the sacrococcygeal cases; the youngest being sixteen years, while the oldest was seventy-two years. Males were in the majority in the ratio of 2:1.

A case report is presented in which a neoplasm which originated in the lower dorsal spine migrated to the pelvis by virtue of a long pedicle. Its presence in the pelvis simulated an ovarian cyst. Only by careful microscopic sections did the diagnosis of chordoma become apparent.—*Mary Frances Vastine*.

GENITOURINARY SYSTEM

CONROY, T. F., and WALKER, J. H. Congenital solitary kidney; case reports and consideration of military significance. *J. Urol.*, Jan., 1945, 53, 4-10.

The incidence of congenital solitary kidney is about 1 in 1,000. Criteria for diagnosis as given by Dourmashkin and Light are as follows; (1) absence of the renal silhouette on the flat film of the abdomen; (2) roentgenological evidence of renal enlargement on the opposite side and possible asymmetry of the psoas muscle shadows; (3) absence of opaque medium on the agenetic side on excretion urography; (4) absence of the ureteral orifice on one side after repeated cystoscopic examinations in an otherwise normally appearing bladder, and (5) absence of indigo-carmin elimination on the affected side.

The authors add a sixth criterion, an associated abnormality of the genital tract. They point out diagnostic pitfalls in the above criteria as follows: (1) failure to visualize the renal shadow on one side on a survey film may be due to hypoplasia, destruction by disease, or the presence of overlying shadows in the abdominal cavity; (2) dye excretion may be prevented by renal or ureteral block or by shock or trauma; (3) indigo-carmin is a crude functional index and not reliable.

Conroy and Walker report 2 cases encountered in a military practice. In the first case cystoscopy for a ureteral block suggested the diagnosis which was confirmed by a flat film of the abdomen and excretory urography. In the second case cystoscopic examination was again responsible for the diagnosis which was confirmed by roentgen studies.

The authors conclude that the anomaly is usually a silent one and only recognized when infection or accident to the solitary kidney occurs. Verification of the presence of two functioning kidneys should be a prerequisite to

surgery on the upper urinary tract. The presence of a solitary kidney is no longer considered an adequate cause for rejection from the military service.—*R. M. Harvey.*

WALD, MAURICE H., and GALLOWAY, A. F. Pituitrin for concentrating diodrast in excretion urography. *Radiology*, Oct., 1944, 43, 358-363.

Posterior pituitary extract has an antidiuretic action and this has been utilized in preparing patients for urography. In the tests described here the patients were given 18 ounces of water and an injection of 0.5 cc. (10 units) of pituitrin. The water was given only for the purpose of putting the antidiuretic effect of the pituitrin to a severe test. The usual procedure would be simply to give the pituitrin one to two hours before the injection of diodrast. But pituitrin may be somewhat dangerous to patient who is already severely dehydrated and in such cases water should be given. The use of the pituitrin results in increased concentration of the diodrast and improved density and detail in the upper urinary tract shadow brought about by its intravenous injection. This technique is of special value when a prompt examination is desired in a patient who has not been dehydrated previously.

The antidiuretic action of pituitrin is probably due to increased reabsorption of water in the proximal convoluted tubules and thin portion of Henle's loop and is accompanied by an increased urinary output of chloride.

A dose of 0.5 cc. pituitrin makes good visualization probable but a smaller dose of 0.2 cc. lessens the probability of unpleasant by-effects from the pituitrin.—*Audrey G. Morgan.*

MISCELLANEOUS

KEMP, L. A. W. Linear radium source dose calculators. *Brit. J. Radiol.*, Oct., 1944, 17, 300-304.

In some cases unscreened dosage figures are sufficient, and obliquity is ignored when allowing for screenage. In these cases it is possible to

obtain dosage figures rapidly by means of a suitable instrument which may be designed in such a way that the combined dosage due to a number of sources in tandem may be found directly by means of it.

Calculators for both screened and unscreened sources are described and illustrated and the formulae on which the calculations are based are given. Isodose curves are given in a plane containing a 25 mg. source, active length 1.9 cm., screenage 1.2 mm. platinum.

The calculator for unscreened sources can be used for a small number of sources in tandem, including ones in which the sources have different line densities. The calculator for screened sources makes use of an electrical method of integration and takes into account both obliquity and non-homogeneity of the radiation. It may be used for one source only or for a number of sources in tandem if the sources have the same line density.—*Audrey G. Morgan.*

SANDLER, BERNARD, and UNGAR, E. M. Geometrical method of dosefinding for radium sources, with special reference to the treatment of carcinoma cervix uteri. *Brit. J. Radiol.*, June, 1944, 17, 190-196.

Accurate determination of dose distribution of radium and roentgen rays was made possible by Mayneord's dose finder. But it requires a great deal of time and Mayneord himself says that rapid methods of three-dimensional dose studies are urgently required. This is particularly true when intracavitary radium is to be supplemented later by external roentgen radiation in the treatment of carcinoma of the cervix. A method of roentgen-ray distribution must be found that will compensate for the gradual fall in radium dosage toward the wall of the pelvis. Such a method is described, based on solid projection geometry. The method of geometric reconstruction and obtaining true projections is described in detail and illustrated with diagrams, a study of which would be required for adequate understanding of the method.—*Audrey G. Morgan.*





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THE DYNAMIC CONCEPT OF THORACIC TOPOGRAPHY

A CRITICAL REVIEW OF PRESENT DAY TEACHING OF VISCERAL ANATOMY*

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INTRODUCTION

BY GENERAL agreement of anatomists, "all topographical descriptions are framed on the anatomical convention that the body is in the erect position" (Cunningham⁷). This, in conjunction with a clearly defined attitude of the upper extremities, is referred to as "the anatomical position." "The cadaver may be placed on the table lying on its back, on its side, or on its face, but for descriptive purposes it is assumed to be standing erect in the anatomical position" (Grant¹³). For reasons of convenience the dissection of the viscera is customarily undertaken with the cadaver lying supine, and this is also the position in which the relation of the thoracic and abdominal organs to the surface features of the body is determined and described in anatomical texts. Yet in view of the previously quoted definition of the anatomical position, it is surprising that so few investigations on the location of the viscera have been undertaken with the cadaver in the upright position.

Taken by itself, the subject of topographical anatomy is of little educational value. Its importance lies in the fact that it furnishes information which is applicable to the study of the viscera in the clinical sciences. The establishment of normal standards for the size, shape and position of the organs in the living is a necessary prerequisite in the field of physical diagnosis and clinical medicine. It goes without saying that the study of the human cadaver by dissection is one of the most helpful methods in the exploration of the form and location of the human viscera, but the limitations of this approach in the field of topographic anatomy should be recognized and the findings corrected in the light of investigations in the living subject by means of roentgen studies. Even the textbooks of physical diagnosis, which concern themselves with the topography of the viscera in the living, employ mostly the time honored norms of conventional anatomy that are based on studies on cadavers.

Several investigators, foremost among

* From the Department of Anatomy, University of Oklahoma School of Medicine. All figures were drawn by Miss Sue Browder, Assistant in the Department of Anatomy.

them Moody and his co-workers^{26,27} in this country and Barclay² in Britain, have re-examined the position and surface projection of the abdominal viscera by roentgenographic methods in the living. The results of their studies have shaken our established beliefs as to the site and relations of the abdominal organs. Particularly have they challenged the static concept of the position of the abdominal viscera as expressed in the teachings of Addison.¹ This author, whose work was published at the turn of the century and whose diagrams are still found in our anatomical texts, divides the abdominal region into a number of small squares and assigns to each organ a definite place in this scheme. In contrast, the authors who have approached the problem by means of roentgen studies in the living, have shown that "the normal abdominal viscera have no fixed shapes and no fixed positions, and that every description of them must be qualified by a statement of the conditions existing at the time of observation" (Barclay²). Where the results of these roentgenographic studies have been included in our teaching of anatomy, they are usually not sufficiently integrated with the conventional presentation of visceral anatomy, but rather are they offered as an appendix to the classical description of the position and relation of the organs. This makes it appear as if the difference in the findings were due to a change in method, i.e., from dissection to roentgenography, and not to a change in the object explored, namely, from the recumbent cadaver to the living subject in its varied posture. It goes without saying that roentgen investigations in the supine cadaver confirm the results arrived at by dissection.

With respect to the thoracic viscera the belief is usually held and set forth in anatomical texts that their shape and position are not subject to marked variations (Lubosch²²). Again, as in the abdomen, conditions found in the recumbent cadaver are presented as the norm, also for clinical purposes. Little or no attention is paid to temporary physiologic alterations in the

site and configuration of the thoracic organs and to constitutional variations from individual to individual. Surprisingly few studies have concerned themselves with the surface relationship of the thoracic viscera as revealed by roentgen study in the living. The investigations which have been undertaken so far have challenged our established opinions on visceral topography of the thorax and have proved that—as in the abdomen—the location of the viscera frequently does not coincide with the position assigned to them from studies on cadavers.

REASONS FOR DISCREPANCIES IN RESULTS OBTAINED BY DISSECTION AND BY ROENTGENOGRAPHY

As to the results obtained in the living by means of roentgen studies and in the dissected cadaver, complete conformity can hardly be expected for the following reasons:

1. In the cadaver all muscles including the diaphragm are either in a state of complete relaxation or of abnormal rigidity due to rigor mortis, there being some displacement of the viscera in either case. The heart muscle likewise changes its configuration considerably after death. Postmortem contraction brings about a decrease in the transverse diameter of the heart which makes it appear more pointed (Roesler²³). This is followed by secondary dilatation. The final shape and size of the heart in the dissecting room depends on the interval that has elapsed between the moment of death and the embalming of the body. The condition of the heart muscle at the time of death and the cause of death are also of influence, since marked myocardial degeneration or wasting diseases preclude pronounced cardiac rigor (Roesler).

2. The cadaver is explored in the supine position with the thorax in a state of extreme expiration, the viscera being displaced dorsally and cranially.

3. The position of the thoracic viscera in the cadaver is investigated usually after the body cavities have been opened with

resulting non-physiologic equalization of pressure.

4. The connective tissue as well as the alveolar spaces of the lung is edematous due to diffusion of embalming fluid.

5. The veins are for the most part desanguinated and the large arteries of the mediastinum decreased in length and width due to the absence of the dilating force of the blood pressure (Roesler).

All these factors work together to produce marked changes in the shape and position of the thoracic viscera in the cadaver. In contrast, these pitfalls are avoided in the roentgenographic exploration of the living, a study which can often be done with the subject in the upright, i.e., the anatomical position and which in the hands of the experienced observer is capable of furnishing valuable information on visceral topography. This shall be exemplified by a comparison of the topographic anatomy of the tracheal bifurcation, of the heart, and of the posterior pulmonary and pleural boundaries as revealed by roentgenography of the living and by dissection in the cadaver.

TOPOGRAPHIC ANATOMY OF THE TRACHEAL BIFURCATION

The bifurcation of the trachea is customarily placed at the level of the intervertebral disc between the fourth and fifth thoracic vertebra or at the level of the upper border of the fifth thoracic vertebra, corresponding to the sternal angle between manubrium and body of the sternum (Fig. 1*d*). But roentgenography of the upright adult subject usually shows the bifurcation considerably lower, commonly at the level of the sixth thoracic vertebra (Bársony and Wald,⁵ Köhler¹⁶). It may be found as low as the seventh thoracic vertebra (Kreuzfuchs,¹⁸ Fig. 1*c*). The discrepancy can readily be explained by the general lowering of all viscera in the upright position which is caused by gravitational pull. Roentgenograms in the supine position usually show the bifurcation at the level of the fourth or fifth thoracic vertebra. Engel has studied

the position of the bifurcation at different ages by means of roentgenograms (Fig. 1, *a* and *b*). According to this author the bifurcation is located at the following levels:

During the first year—at the level of the third or fourth thoracic vertebra

From the second to the sixth year—at the level of the fourth or fifth thoracic vertebra

From the seventh to the twelfth year—at the level of the fifth or sixth thoracic vertebra.

Thus the bifurcation of the trachea participates in the descent of the viscera which is a general phenomenon that takes place during the life span of the individual, and which will be referred to also in connection with the heart and the inferior boundaries of the lungs. Anatomical texts frequently speak of the bifurcation of the trachea as being fixed in position (Morris,²⁸ Cunningham⁷), yet—disregarding the contradiction—quote the roentgen studies by Macklin,²³ which prove a respiratory shift in the location of the bifurcation.

TOPOGRAPHIC ANATOMY OF THE HEART

The relationship of the roentgen silhouette of the heart to the anterior thoracic wall in the living has not been investigated sufficiently to serve as a foundation for our teaching of cardiac topography or as a clinical standard in physical diagnosis. Anatomical texts as well as treatises on physical diagnosis commonly base their presentation of this important subject on studies of cadavers. Thus, to give one example, Morris²⁸ discussion of the topographic anatomy of the heart rests on LeWald's roentgen studies "of a formalin preparation of the anterior thoracic wall with the heart, pericardium, and diaphragm in situ." But the roentgenogram of this preparation (Morris' Fig. 488, 10th edition) reveals the cadaveric state of the thorax and the diaphragm and can therefore hardly be used as a standard for the living. For reasons previously discussed the surface projection of the heart of the cadaver differs considerably from the surface relationship of this organ in the living, par-

ticularly if we presuppose that the body is in the anatomical, i.e., upright position.

Why then, we may ask ourselves, has not the roentgenographic study of the living in the upright position, which avoids all these pitfalls, been used as the main

configuration. In addition, it is not clearly outlined on the roentgenogram since the important landmarks of sternum and costal cartilages are hardly visualized. The upper and lower borders of the heart are not depicted directly on the roentgenogram but

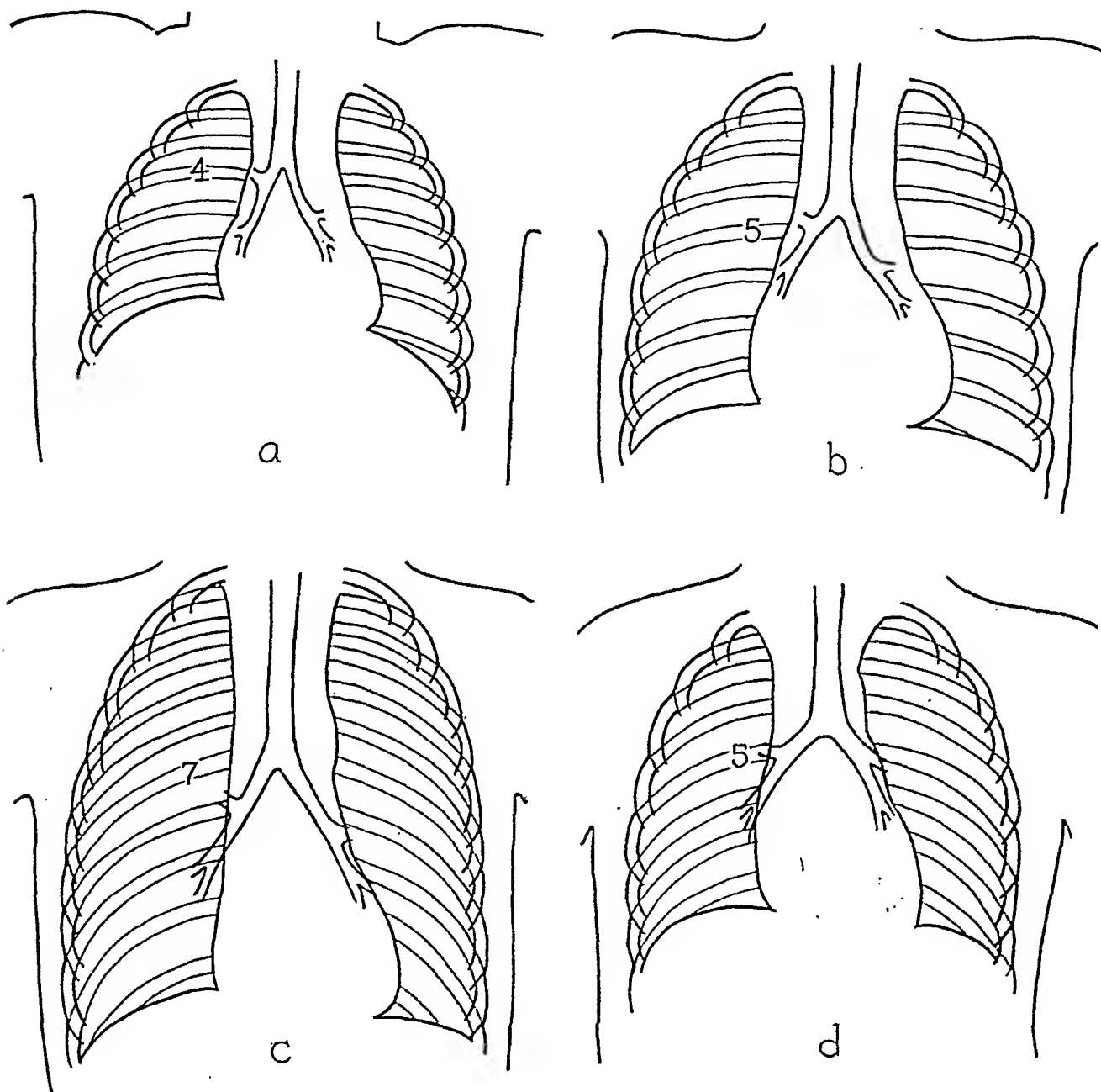


FIG. 1. The variable position of the tracheal bifurcation: *a*, in the newborn (after Engel¹¹); *b*, in a child, three years old (after Engel¹¹); *c*, in the upright adult (after Kreuzfuchs¹²); *d*, in the adult cadaver (after Cunningham⁷).

source of information on the topography of the heart? The answer lies in the difficulties of this undertaking. The anterior thoracic wall, which serves as the plane of projection, does not represent a constant, but is subject to numerous variations in its

have to be drawn somewhat arbitrarily by connecting the right and left superior and inferior terminal points of the lateral contours. But the main difficulty is caused by the fact that, as a result of physiological alterations, the heart is subject to continu-

ous changes in its absolute and relative dimensions and therefore also in its surface relationship. Furthermore, there are great normal variations in the size, shape and position of the heart from individual to individual as an expression of differences in body build, age, sex, weight, height, and muscular development.*

FACTORS INFLUENCING CARDIAC CONFIGURATION

A. Position of the Diaphragm

Variation in the position of the diaphragm is the greatest single factor re-

tion, is accompanied by a descent of the heart. At the same time the heart undergoes a rotation around its longitudinal axis so that its apex is turned forward and medially. The right margin, being relatively fixed in its position by the attachments of the two venae cavae, takes part in these movements only to a lesser degree (Fig. 2). The reverse movement occurs in expiration.

The influence of diaphragmatic position on cardiac dimensions can best be studied by comparing the roentgen silhouettes in the two extremes of diaphragmatic loca-

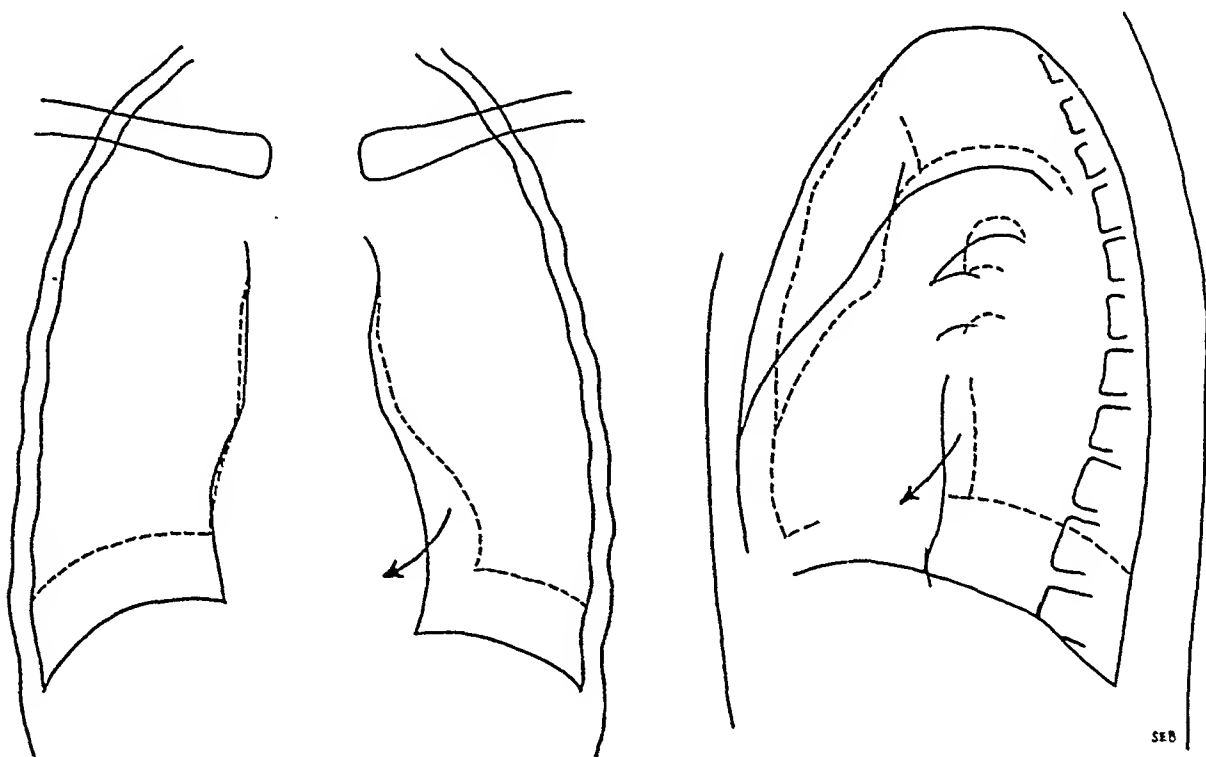


FIG. 2. Rotation of the heart in inspiration (posteroanterior and lateral views).

sponsible for marked differences in cardiac configuration and its surface projection. This is understandable if one realizes that the heart is firmly attached to the central tendon of the diaphragm by means of the pericardium and that it must follow all diaphragmatic excursions. Consequently a lowering of the diaphragm, e.g., in inspira-

tion. Diagram *a* of Figure 3 depicts a thorax with a markedly elevated diaphragm. Its dome is approximately at the level of the posterior portion of the eighth rib. The heart appears short and wide, somewhat comparable to a "lying egg." The waist of the heart, i.e., the constriction between the vascular and cardiac portions of the silhouette is quite pronounced, hence the flare below the waist is marked. Its transverse diameter and particularly *MI* are large, *MI* being more than twice the

* The following roentgen-ray physiological discussions are based on the clinical experiences of the author and careful perusal of the literature, particularly of the monographs by Dietlen,¹⁰ Roesler,²³ Groedel,¹⁴ Zdansky²³ and Kurtz.²⁰

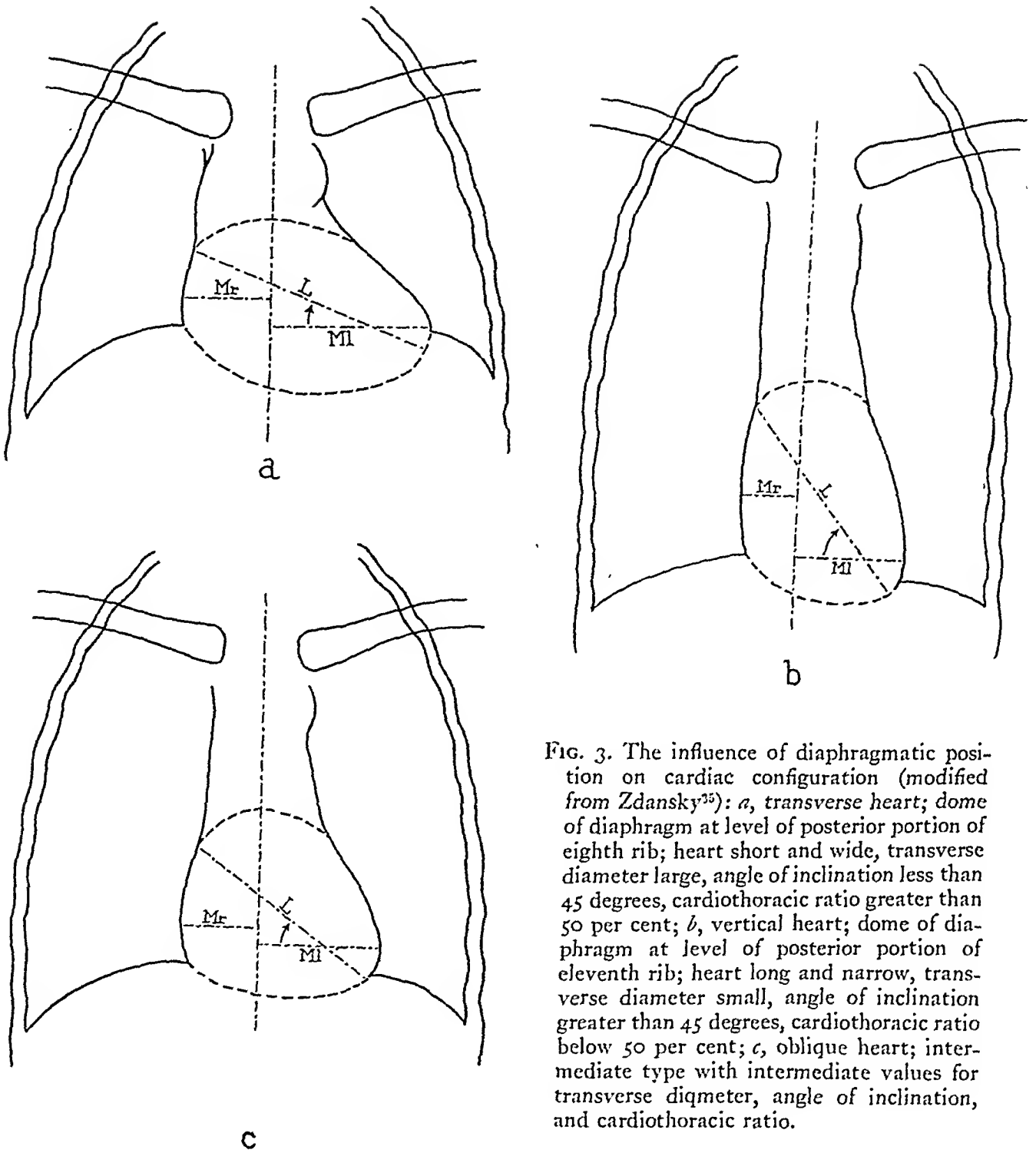


FIG. 3. The influence of diaphragmatic position on cardiac configuration (modified from Zdansky³⁵): *a*, transverse heart; dome of diaphragm at level of posterior portion of eighth rib; heart short and wide, transverse diameter large, angle of inclination less than 45 degrees, cardiothoracic ratio greater than 50 per cent; *b*, vertical heart; dome of diaphragm at level of posterior portion of eleventh rib; heart long and narrow, transverse diameter small, angle of inclination greater than 45 degrees, cardiothoracic ratio below 50 per cent; *c*, oblique heart; intermediate type with intermediate values for transverse diameter, angle of inclination, and cardiothoracic ratio.

length of *Mr*.^{*} Its longitudinal diameter *L*

* *Mr*, the median right diameter, is the distance from the midline to the farthestmost point of the right heart contour. *MI*, the median left diameter, is the distance from the midline to the farthestmost point of the left heart contour. *T*, the transverse diameter of the heart, represents the sum of *Mr* and *MI* and therefore the maximal distance between the right and left heart borders. *L*, the longitudinal diameter of the heart, is the distance from the junction of the vascular and cardiac right arches to the outermost and lowest point of the cardiac apex. The angle of inclination is the angle formed by *L* and *MI*. The cardiothoracic ratio represents the ratio of the transverse diameter of the heart to the inner diameter of the chest. The frontal surface area is the cardiac area on the posteroanterior roentgenogram after arbitrary completion of the upper and lower heart borders.

approximates the horizontal which implies that the angle of inclination is small, less than 45 degrees, the cardiothoracic ratio is greater than 50 per cent, i.e., the transverse diameter of the heart is larger than half the width of the thorax. Its frontal surface area is relatively large.

In contrast to this is the heart silhouette of diagram *b* of the same figure, which represents the other extreme. Here the diaphragm is low with its dome approxi-

mately at the level of the posterior portion of the eleventh rib. The heart appears long and narrow and can be compared to a "standing egg." Its waist is not well marked, vascular and cardiac portions of the silhouette fuse into each other more gradually. The transverse diameter is smaller, MI is less than twice the length of Mr , the longitudinal diameter L is more vertical, i.e., the angle of inclination is larger than 45 degrees, the cardiothoracic ratio is below 50 per cent, the frontal surface area is relatively small.

The two diagrams *a* and *b* represent, of course, extremes in cardiac types resulting from maximal deviations in the position of the diaphragm. Intermediate types are readily visualized. Diagram *c* of the same figure depicts such a heart whose diameters, relation of MI to Mr , angle of inclination and cardiothoracic ratio fall between the measurements for the other two types. The terms "transverse heart" for type *a*, "vertical heart" for type *b*, and "oblique heart" for the intermediate type *c* are frequently used.

For the purpose of this discussion on the varying surface relationship of the heart, it is not very relevant whether differences in cardiac dimensions in the frontal roentgenogram are the expression of differences in actual cardiac size; in other words, whether enlargement or decrease in size of cardiac diameters of the frontal silhouette necessarily prove corresponding changes in heart volume. The answer is negative. As far as changes in individual diameters are concerned, it is of course readily seen that diminution in the transverse diameter may be compensated by lengthening of the longitudinal diameter. But even if planimetric determination of the frontal surface area demonstrates increase or decrease of the frontal silhouette, this does not necessarily indicate change in cardiac volume, since diminution of the frontal area may be balanced by a corresponding increase in cardiac depth, or vice versa. Thus to name one example, inspiratory reduction of the transverse diameter may be associated with

increase or decrease in size of the longitudinal diameter. In the latter case diminution of frontal surface area is demonstrable. Yet this is no definite proof of reduction in cardiac volume for reasons just mentioned. Actually it has been demonstrated by volumetric determinations that inspiratory decrease in frontal surface area is consistent with increase, decrease or no change in cardiac volume.

Respiration. We have seen that the heart follows the inspiratory descent and expiratory rise of the diaphragm. In addition, the heart undergoes an inspiratory forward rotation of its apex around the longitudinal axis of the organ and a reverse movement in expiration. The movements vary with the intensity and type of breathing. While changes in cardiac configuration are not very marked in quiet breathing, large respiratory excursions of the diaphragm lead to distinct changes in the frontal silhouette of the heart. Thus deep inspiration results in a more vertical heart figure, while maximal expiration brings about a transverse configuration (Fig. 4*a*).

Body Posture. When the body changes from the vertical to the horizontal position, the heart ascends with the diaphragm and rotates around its own longitudinal axis so that the apex moves toward the left and posteriorly, assuming on the whole a more transverse shape (Fig. 4*b*, solid lines—supine position, dotted lines—vertical position). In the sitting position the heart frequently adopts an intermediate position, as shown in the same figure (Fig. 4*b*, dashes). These changes in cardiac position should be kept in mind in physical examination of the heart, where cardiac configuration may be studied in the standing, sitting, or recumbent position, depending on the wellbeing of the patient and the preference of the examiner.

Other Factors Affecting the Position of the Diaphragm. Respiration and changes in body posture are not the only physiological variants that affect the position of the diaphragm and consequently the configuration of the heart. Others are the state of

filling of the viscera, large deposits of fat in the abdomen, pregnancy, sex, age, and thoracic build. In general, it can be said that all factors that raise the level of the diaphragm, let the heart approximate the transverse type *a* of Figure 3, while all factors that lower the diaphragm, tend to produce a cardiac configuration similar to type *b*. The extent of diaphragmatic rise or descent determines also the degree of resemblance to the illustrated examples. Thus a normally oblique heart may assume transverse shape with maximal elevation of the

matic position is accompanied by a more or less vertical heart with a smaller transverse diameter, a larger angle of inclination (larger than 45 degrees) and a cardiothoracic ratio of less than 50 per cent, while a high diaphragm is usually associated with a transverse heart of larger transverse diameter with a smaller angle of inclination and a cardiothoracic ratio greater than 50 per cent.

B. Constitutional Type

We have seen so far that the heart may

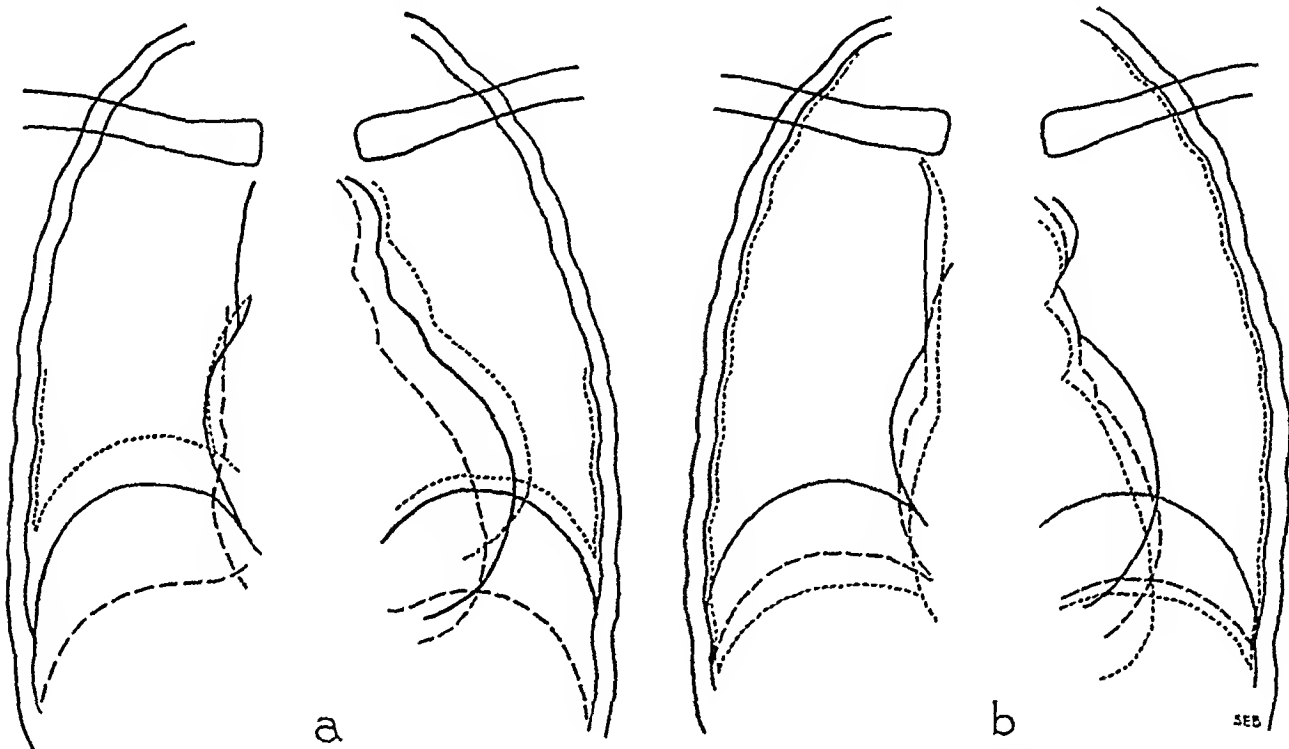


FIG. 4. (After Dietlen.¹⁰) *a*, changes in cardiac configuration during respiration. Solid lines indicate quiet breathing, dashes outline the heart and diaphragm in deep inspiration, dotted lines in expiration. *b*, changes in cardiac configuration with alterations in body posture. Solid lines indicate supine position, dashes outline heart and diaphragm in the sitting position, dotted lines in standing position.

diaphragm due to overfilling of the intestines (Fig. 5*a*). Or a heart which during the later months of pregnancy adopts a transverse configuration, will revert to its original oblique type during the puerperium (Fig. 5*b*).

The examples just mentioned have been chosen to illustrate the important concept of changing heart configuration as a result of variations in the position of the diaphragm. Usually the variations are not as marked as the extremes of Figure 3. In general, it can be said that low diaphragm

change its configuration depending on changes in the position of the diaphragm. But there exist also variations from individual to individual which are the expression of differences in constitutional build. If we inspect a series of roentgenograms of normal subjects taken in the same respiratory phase and in the same position of the object, e.g., during quiet respiration and in the upright position, we encounter all three cardiac types described above, although not with equal frequency. The most common type, particularly in well proportioned

adult males, is the oblique heart, but the transverse and vertical hearts also occur frequently. A correlation can often be established between body habitus, configuration of the thorax, and the type of heart. Thus the tall, slender individual with the long, narrow thorax is most likely to have a vertical heart, while the heavy-set, stocky individual with a short and wide chest in all probability has a transverse cardiac sil-

houette. The relationship between transverse diameter of the heart and width of the chest.

C. Age and Sex

The heart of the newborn and the young infant is globular in shape. Subdivision of its contours into clearly outlined arches is not present, its waist is obliterated due to protrusion of the pulmonary arch, and the aortic knob is frequently absent (Fig. 6a).

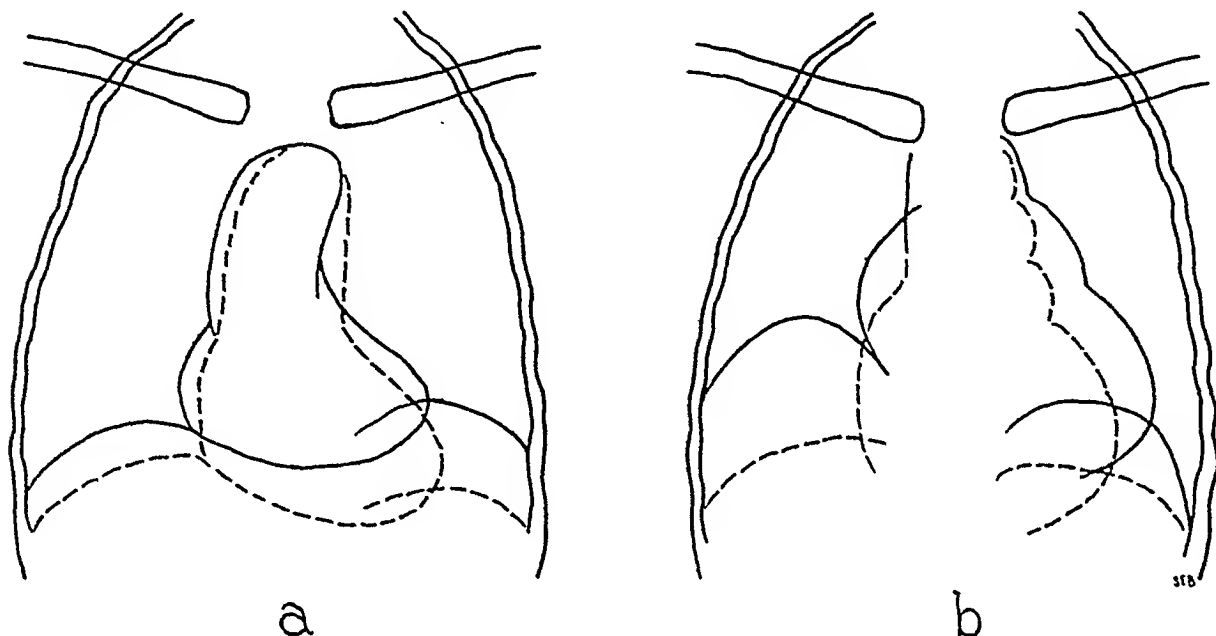


FIG. 5. Changes in the position of the diaphragm and in cardiac configuration: *a*, with variations in the filling of the intestines. Solid lines represent the position of heart and diaphragm before, and dotted lines after evacuation of distended intestines (after Kudisch¹⁹). *b*, during and after pregnancy. Solid lines indicate position of heart and diaphragm during ninth month of pregnancy, dotted lines depict position nine days postpartum (after Dietlen¹⁰).

houette. Intermediate types most frequently display an oblique heart. While this parallelism can be attributed partly to variations in diaphragmatic position—the diaphragm is commonly lower in the narrow chest and higher in the broader thorax—it also has its cause in variations in the shape of the chest as seen in cross sections. Apparently the heart adapts itself to the dimensions of the thoracic cavity so that deep-chested individuals have a larger depth diameter of the heart and flat-chested subjects a correspondingly flatter heart. But exceptions to this rule also occur. The use of the cardiothoracic ratio is based on

The heart is of the transverse type with a small angle of inclination. Its transverse diameter is rather large and the cardiothoracic ratio is higher than 50 per cent. The silhouette as a whole is short, its vascular component wide. The described configuration is explained by: (1) the high position of the diaphragm, (2) the superimposition of the thymus, (3) differences in angulation of the longitudinal axis of the heart as compared with the heart of the adult (Zdansky³³).

The high position of the diaphragm in the infant is normal and is exaggerated by large gas filling of the stomach and the intestine.

The relatively large size of the liver is also a contributing factor. The shadow of the thymus fuses with the cardiac silhouette and usually cannot be separated from the latter. Differences in thymic size and shape also explain the marked variations of the mediastinal shadow in early infancy. The longitudinal axis of the infant's heart approximates the horizontal in the frontal plane—the angle of inclination is usually

verse configuration and assumes more the shape of the adult heart. Correspondingly the cardiothoracic ratio decreases and the angle of inclination increases. All investigators of the child's heart note the great variability of all cardiac dimensions. During periods of particularly accelerated body growth heart size may temporarily lag behind other body measurements.

It would be expected that the descent of

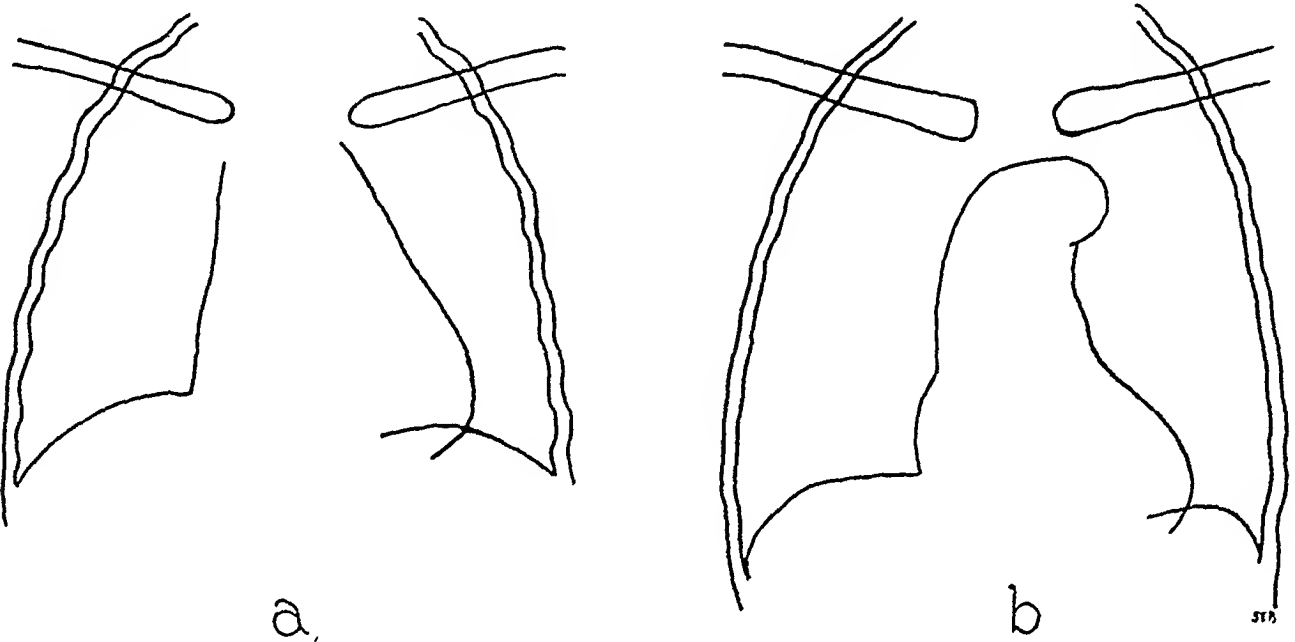


FIG. 6. *a*, infant's heart. No subdivision of its contours, obliteration of the cardiac waist, absence of aortic knob, large transverse diameter with cardiothoracic ratio greater than 50 per cent. *b*, senile heart. Heart of transverse type with protruding and elongated aorta.

not larger than 20 degrees—as well as in the sagittal plane, as demonstrated in profile view, so that the large thoracic vessels, instead of running vertically upward, take an almost horizontal course with posterior inclination. This leads to considerable foreshortening and widening of the cardiovascular silhouette in the standard roentgenogram. Abnormal broadening of the vascular component of the shadow is often due to crying of the infant during exposure resulting in overfilling of the superior vena cava. Related to total body weight the heart of the newborn is larger than at any other age.

As age increases, the diaphragm descends and the thorax flattens anteroposteriorly. Thus the heart loses its pronounced trans-

verse configuration in advanced age should be accompanied by a lengthening of the heart shadow and change to a more vertical configuration, but contrary to expectations we find the heart in old age usually represented by the transverse type. This can be partly explained by rotation of the heart to adapt itself to elongation of the aorta (Fig. 6*b*). But actual increase in cardiac size in old age is also a factor.

The female heart approximates in general more the described infantile type. The waist of the heart may be obliterated. The silhouette frequently is of the transverse type with small angle of inclination and relatively large transverse diameter, particularly its *Ml* component. The causes for these peculiarities lie in the high position of

the diaphragm and the shape of the female thorax which is short and deep:

D. Weight and Height

There is a direct correlation between heart size and body weight; indeed, heart size parallels body weight more closely than it does any other single factor. Further investigation reveals that more than any other body tissue the amount of skeletal musculature is the factor which is most closely related to the size of the heart. Thus, of two individuals of the same body weight, the one with the better developed skeletal musculature will usually have the larger heart. It also explains why obese persons commonly fall in their heart dimensions below the figures expected by their weight.

Heart size can also be correlated to body height. Tables show that cardiac dimensions rise with increasing height, but this holds true only for the harmoniously built individual. Where length development is not in proportion to body width, no correlation between heart size and body height exists. Thus the tall slender subject reveals cardiac measurements smaller than are expected from his height. In general, height does not parallel cardiac size as closely as weight.

E. Cardiac Phase and Pulse Rate

It is readily understood, yet often neglected in appraising cardiac size, that the heart is subjected to variations in size depending on the phase of the cardiac cycle, diastole leading to widening, systole to contraction of the silhouette. Orthodiagraphy, in order to exclude this source of dimensional variations, customarily outlines all cardiovascular contours in the diastolic position, i.e., at their maximal distance from the midline. Thus a silhouette is reproduced which actually never exists at any moment of the cardiac cycle.

Pulse rate is likewise of influence on heart size. Tachycardia, which causes shortening of the diastole and therefore a decrease in the stroke volume, produces a diminution of cardiac size, and bradycardia for op-

posite reasons, an increase in cardiac dimensions. But minor alterations in heart rate do not noticeably affect the size of the silhouette.

SURFACE PROJECTION OF THE HEART

The preceding discussion on the variability of cardiac configuration in the normal furnishes convincing proof that the standard figure on the surface projection of the heart, as given in anatomical texts, is of questionable value. It has been demonstrated that cardiac surface relationship is not a fixed and static entity, but is dependent on a series of variable factors, which have to be defined in the individual case. If for didactic reasons a single schematic representation is desired, it certainly should not depict the conditions in the cadaver, but in the living. Such a schematic figure can be obtained with sufficient accuracy only by means of roentgenograms. Variable factors within the same individual have to be reduced to their minimum by standardizing roentgenographic procedure, with particular attention to respiratory, postural, and pulsatory changes in the size, shape, and position of the heart. Recognized statistical methods should be employed to insure correct evaluation of variations between different individuals.

In view of the difficulties previously discussed, sufficient roentgenographic studies on the topography of the heart are not available to present this subject in final form. But roentgenographic data recently collected by Mainland and Gordon²⁵ give a chance to compare the facts at hand with those in the anatomical literature. From this evidence the assumption seems justified that the standard diagram of the projection of the heart on the anterior thoracic wall is incorrect in the living subject in the erect position. If the roentgenogram of the upright subject is taken in the neutral respiratory phase midway between inspiration and expiration, the following is the average position of the heart in the young male adult (Mainland and Gordon²⁵):

Corner of Heart	Costal Level*	Distance from Midline
Upper left	Lower part of third rib	3 cm.
Upper right	Upper part of fourth rib	nearly 3 cm.
Lower right	Fifth intercostal space	4 cm.
Lower left	Lower part of sixth rib	7 cm.

Particularly important is the location of the lower cardiac border. It crosses the mid-

The lower border passes from the apex through the xiphisternal joint.

The discrepancies of these two surface projections become most evident on diagrams drawn from the specifications of these tables (Fig. 7). A comparison reveals that the heart of the erect living subject lies considerably more caudad than the cadaver

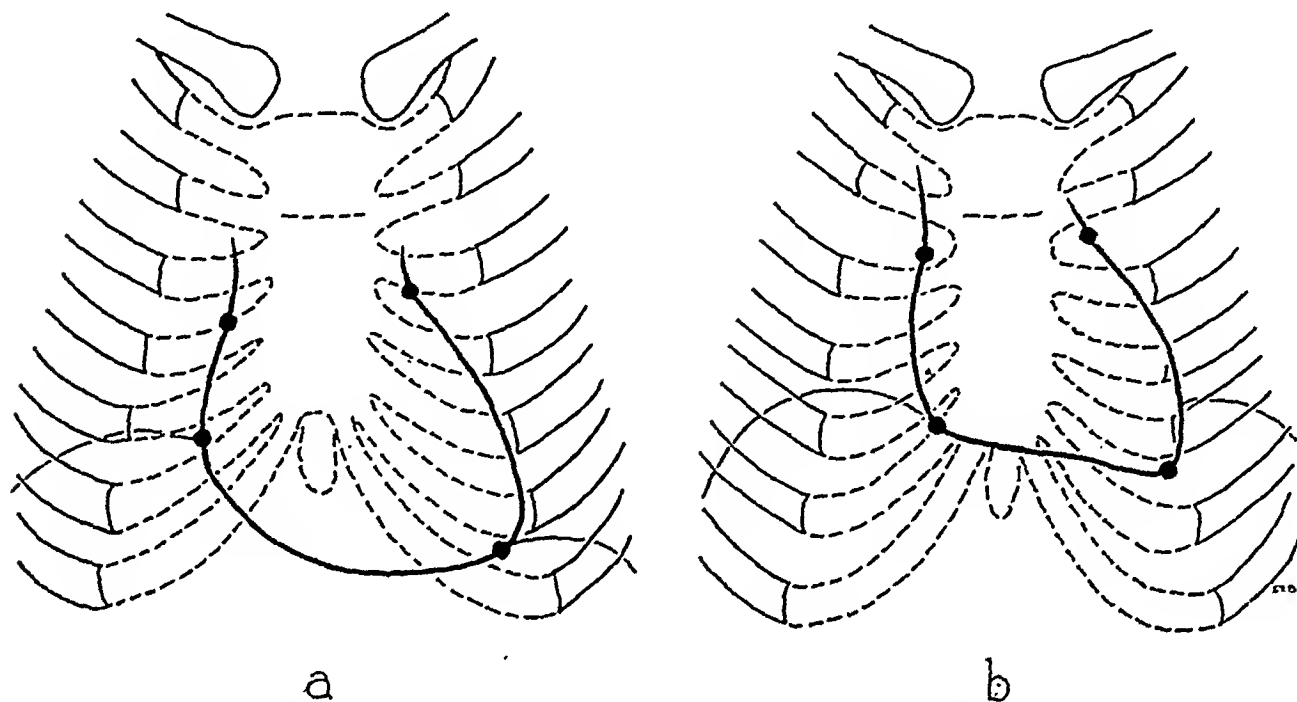


FIG. 7. Surface projection of the heart: *a*, in the upright living subject (drawing after data from Mainland and Gordon²⁵). *b*, after Morris.²⁸

sternal line 5.5 cm. below the xiphisternal joint.

The position of the heart as given in anatomical texts (Morris, 1933) is the following:

Corner of Heart	Costal Level	Distance from Midline
Upper left	1 cm. below second chondrosternal articulation	3 cm.
Upper right	1 cm. above third chondrosternal articulation	3 cm.
Lower right	Sixth costal cartilage	2 cm.
Lower left	Fifth intercostal space	7.5-8 cm.

* The designation "costal level" refers to the part of the rib or intercostal space overlying the cardiac shadow at the corner under investigation. Where, as in the case of the cartilaginous portion of a rib or intercartilaginous part of an intercostal space, the relationship cannot be read off directly from the roentgenogram due to the invisibility of the costal cartilage, the costal level was identified by wire markers (personal communication from Dr. Mainland).

heart. Particularly striking is the contrast in the location of the lower border. This is determined by Mainland and Gordon from lateral roentgenograms and related to wire markers at the xiphisternal joint. After careful consideration the two authors find their result free from any bias.* They likewise call attention to the fact that the described location places the sternocostal surface of the heart in the erect subject almost as far below the xiphisternal joint as above it; in other words, a plane laid through the joint would nearly bisect the anterior surface of the heart. The main difficulty in visualizing the low extent of the inferior cardiac border lies in the fact that, according to general concept, the dia-

* In a recent publication (D. Mainland: *Anatomy as a Basis for Medical and Dental Practice*, Paul B. Hoeber, 1945) the author concedes that the lower border of the heart in the midline should possibly be a centimeter higher, which would place it 4.5 cm. below the xiphisternal joint.

phragm passes from its insertion on the xiphoid process backward and upward. This would of course preclude the heart from reaching a level more caudad than the xiphoid process, at least in the midline. Since the roentgenograms definitely reveal the inferior border of the cardiac silhouette below this landmark, the diaphragm must pass from the xiphoid process not backward and upward, but first backward and downward allowing for the caudal expansion of the heart which produces a distinct impression on the liver. This is also the explanation which Mainland and Gordon offer for this surprising result.

The discrepancy in the location of the lower right corner of the heart seems to be more one of definition than of actual topography. Anatomical texts apparently place it at the termination of the inferior vena cava, while Mainland and Gordon locate it somewhat more laterally at the point of the cardiac silhouette where diaphragm and right border of the heart meet. The former definition seems more acceptable.

In view of the discrepancies between the topography of the heart in the upright, living individual and in the cadaver the question is indicated: How does the position of the heart in the recumbent living subject compare to its location in the cadaver? In the horizontal position the diaphragm is considerably higher, and the heart therefore should approximate the cadaveric location. Again reference is made to investigations by Mainland and Gordon who give the following surface projection of the heart in this state:

Corner of Heart	Costal Level	Distance from Midline
Upper left	Upper part of third rib	nearly 4 cm.
Upper right	Lower part of third rib	3 cm.
Lower right	Fifth rib	4 cm.
Lower left	Lower part of fifth intercostal space	7.5 cm.

The lower border crosses the midline 3.5 cm. below the xiphisternal joint.

Leaving aside the differences in the location of the right lower corner which have

been explained, we see that the surface projection of the living heart in recumbent subjects approximates the cadaveric position much closer than in the upright individual, although it still is not situated as far craniad as textbooks describe it.

Summarizing these observations on the location of the heart in the living, we notice that there are considerable differences between the conventional descriptions and the roentgen findings in the upright, living subject. Here the heart lies much lower than usually assumed. Particularly surprising is the location of the inferior cardiac border, which is given as crossing the midline on the average 5.5 cm.* below the xiphisternal joint. The heart of the recumbent living subject approximates the cadaveric position, but still does not lie as far craniad. The results of these interesting studies require confirmation on a series of individuals which is more representative of a cross section of the whole population than the authors' young male student material, but it is anticipated that a revision of our concept of cardiac topography is necessary.

Although the position of the heart valves cannot be determined directly on the roentgenogram of the living, it can be deduced from the foregoing description that the standard anatomical diagram of the surface projection of the cardiac valves is not correct for the upright individual. Further investigations, particularly with the help of contrast filling of the heart chambers, are needed to put our concept of the location of these valves in the living on a more exact basis.

TOPOGRAPHIC ANATOMY OF LUNGS AND PLEURA

The lungs and pleura are not as favorable an object for roentgenographic study of their topography in the living as the heart. Large portions of the lungs are invisible on the standard roentgenogram, since they are concealed by the homogeneous abdominal and mediastinal densities. As to the normal

* 4.5 cm. according to a recent correction by Mainland (see preceding footnote).

pleura, the contention is frequently made that it is entirely outside the realm of roentgenographic demonstrability. On closer scrutiny, conditions are not as unfavorable. The normal pleura can be visualized under propitious circumstances, i.e., if the rays strike the pleural surface tangentially to a sufficient extent and if there is adequate contrast between the pleural membrane and adjacent regions. This is exemplified by the visibility of the normal visceral pleura in pneumothorax where it is bounded by air-containing spaces on both sides. It is further illustrated by demonstration of the normal interlobar septum and of the interlobar fissure in accessory lobes. While it is true that considerable portions of the lungs are obscured by adjacent abdominal organs and the mediastinal shadow, proper technique and favorable conditions in the subject not infrequently reveal the posterior mediastinal and posterior inferior extent of lungs and pleura. It seems a worthwhile undertaking to compare these boundaries with those found in the cadaver.*

A. Posterior Mediastinal Boundaries of Lungs and Pleura

According to conventional anatomical teaching the posterior costal pleura is continuous with the mediastinal pleura along a vertical line on the anterolateral aspect of the vertebral bodies. This line of pleural reflection extends from the first to the twelfth thoracic vertebra, where it becomes continuous with the diaphragmatic reflection. The extent of the lungs in the posterior mediastinal region is supposed to coincide with the line of pleural reflection. The posteromedial margins of lungs and pleura define also the configuration of the posterior portion of the mediastinum. This is consequently regarded as a rather wide space in which the esophagus is in close

contact with the anterior surface of the spinal column.

What are the roentgen findings relating to these boundaries of lung and pleura? A number of detailed roentgenographic studies on this subject are available (Pratje,³² Danelius,^{8,9} Bársony and Wald,⁴ Stéphanie and Kirsch,³⁴ Maier,²⁴ Lachman²¹), but they have so far not been included in our teaching of this important chapter of topographic anatomy. The demonstration of these boundaries on the routine chest roentgenogram is rare; only on films taken with high roentgenographic penetration and preferably with a Potter-Bucky diaphragm is it at all possible to identify the upper medial lung portions as a more translucent area superimposed on the shadow of the spinal column. The medial contour of this translucency describes a medially convex arc which arises in the apical field and continues downward in or close to the midline (Fig. 8). At the level of the fourth or fifth thoracic vertebra the lung margins of the two sides approximate each other leaving but a small interval between them. In addition to the pulmonary translucency the corresponding pleural reflections of the two sides may appear as thin lines visible within the tracheal translucency (Fig. 8).

In stereoroentgenographic studies in the living with barium filling of the esophagus, Pratje³² demonstrated that the distance between esophagus and spinal column at the level of the fourth and fifth thoracic vertebra amounts to 2-4 cm. This space is occupied by pleural recesses into which medial portions of the lungs extend. In roentgenographic investigations on the cadaver and in the living, Danelius⁸ confirmed the presence of a retro-esophageal space which is occupied by lungs and pleura. This space deepens during inspiration and in the upright position, while it becomes more shallow during expiration and in the supine posture. The space is larger where the thoracic curvature is pronounced or where there is a distinct thoracic kyphosis, and it may be absent if this curve

* Other pulmonary and pleural boundaries, e.g., the anterior mediastinal or anterior inferior, are excluded from this discussion, since they can be visualized on the roentgenogram only in rare instances.

is ill defined. Presence of lung and pleura in this retro-esophageal location is more common on the right side, and the right mediastinal pleura frequently encroaches on the territory of the left pleura by crossing over the midline.

In the light of these roentgenographic investigations, we must revise our concept of the upper mediastinal boundaries of lung and pleura. Very instructive is a comparison of cross sections illustrating the two concepts. In Figure 9*a*, the lungs and pleural cavities according to conventional anatomical description are separated posteriorly by a wide mediastinal space in which the esophagus is found directly in front of the spinal column. In contrast to this, the corrected diagram *b* depicts the esophagus overlapped posteriorly by retro-esophageal portions of lung and pleura.

In a recent anatomical study (Lachman²¹) attention has been called to the interesting fact that, while older continental

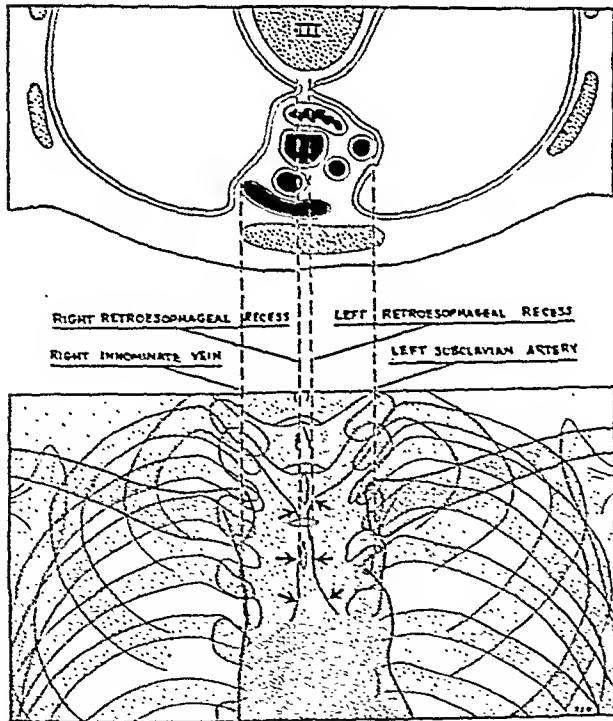


FIG. 8. *Upper*: Cross section through mediastinum at level of third thoracic vertebra. *Lower*: Diagram after roentgenogram depicting the lungs in the retro-esophageal pleural recesses superimposed on trachea and spinal column. Dotted lines indicate the anatomical substrate of pleural lines and of vascular contours in cross section.

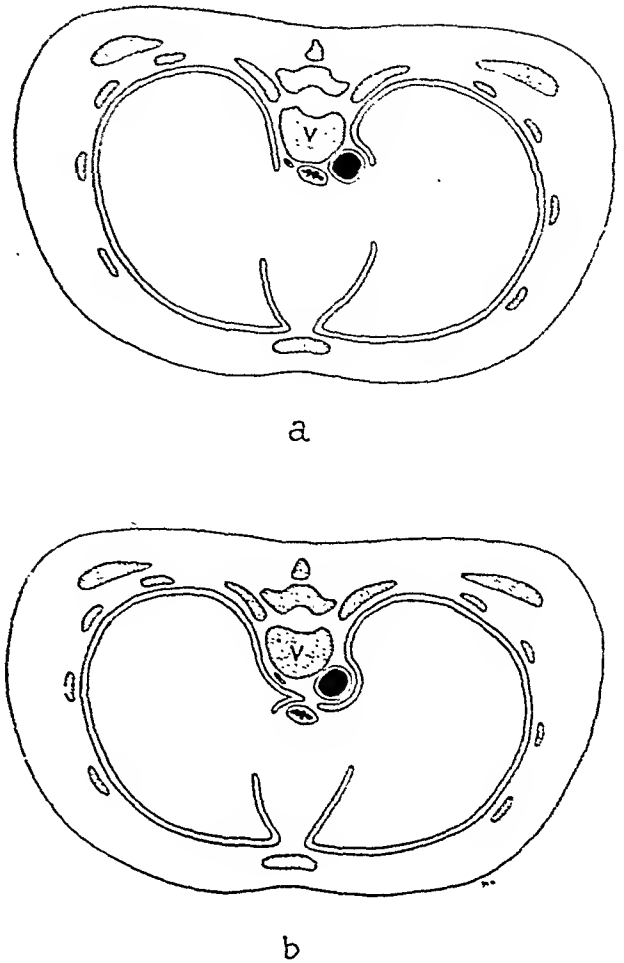


FIG. 9. Cross section through the posterior mediastinum at level of fifth thoracic vertebra. *a*, diagram according to conventional anatomical teaching. *b*, diagram incorporating roentgen findings in the upright living subject. Observe retro-esophageal pleural recess containing lung on right side in *b*.

anatomists were familiar with this retro-esophageal recess, almost all our current English texts disregard it. Few data are available dealing with the frequency of the prevertebral cul-de-sac. Heiss,¹⁵ who undertook careful anatomical investigations on the posterior pleural boundaries of the mediastinum by means of injection of solidifying material and following dissection, found the recess in 70 per cent of his cases. He further states that the rest of his cadavers showed irregular posterior pleural boundaries which almost never confirmed the conventional textbook descriptions. Stéphanie and Kirsch³⁴ observed roentgenographic expansion of the right lung into the mediastinal region beyond the midline in

30 per cent of their cases. The recess is most often visualized in children and in subjects with marked dorsal curvature. The upright position and deep inspiration are required

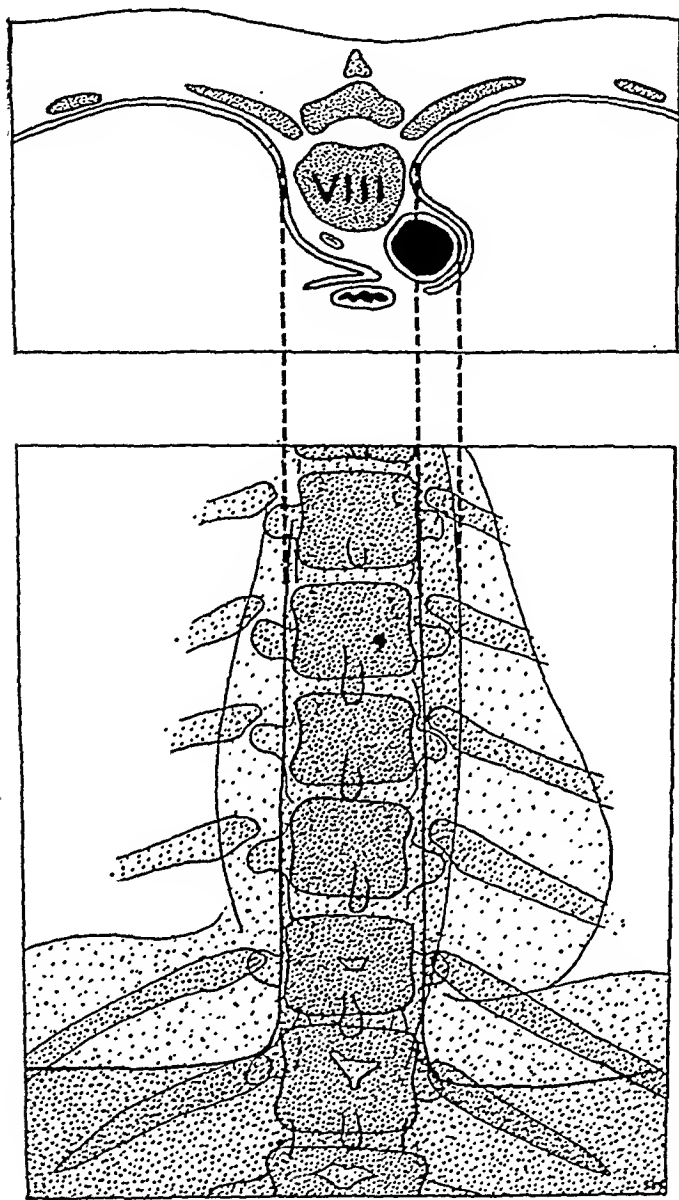


FIG. 10. *Upper:* Cross section through posterior mediastinum at level of eighth thoracic vertebra. *Lower:* Diagram after roentgenogram depicting posterior portions of visceral and/or parietal pleura as lines accompanying the vertebral column. Dotted lines indicate the anatomical substrate of pleural lines and of aortic shadow in cross section. (From Lachman.)²¹ (Reproduced by permission from *Anal. Rec.*, 1942, 83, 521-542.)

to demonstrate the maximum medial extent of the lungs. In the supine position and in expiration the lungs apparently recede from the pleural cul-de-sac. Insufficient data are available to demonstrate the pos-

sible variability of pleuropulmonary topography with age and constitutional factors.

Although older anatomists have called attention to the presence of a pronounced pleural recess in the lower posterior mediastinum, it has not been possible to demonstrate it roentgenographically below the fifth thoracic vertebra; indeed a paravertebral roentgenographic line has been described to the left, and more rarely to the right of the spinal column which is attributable to tangential projection of the paraspinal margins of the mediastinal pleura (Lachman,²¹ Garland,¹² Brailsford⁶). The presence of these pleural lines to the sides of the spinal column seemingly precludes the possibility of pleural cul-de-sacs extending to or over the midline. Yet this is not necessarily the case, since the appearance of pleural lines farther laterally corresponding to the most posterior portions of the pleura does not rule out the presence of pleural recesses more anteriorly behind the esophagus, and therefore does not disprove the correctness of older anatomical observations (Fig. 10) (Lachman).

B. Posterior Inferior Boundaries of Lungs and Pleura

The posterior inferior margins of the pleura are customarily described as horizontally or medially ascending lines which meet the spinal column at the level of the twelfth costovertebral articulation. Some texts locate the inferior extent of the pleura half a vertebra lower. The lower posterior boundaries of the lungs are given as one to two intercostal spaces higher than the pleural margins. This information is based on studies of fresh or preserved cadavers. In the former case, the diaphragm has reached its highest possible position and the lungs are in a state of total collapse, thus producing an entirely unnatural position of the pulmonary margins. In the preserved cadaver the location of the lower lung boundaries is said to correspond approximately to the neutral respiratory phase, i.e., a state of quiet breathing. In inspiration the lungs are supposed to extend to the

level of the spinous process of the eleventh thoracic vertebra, a finding which is based on percussion. This method, while entirely capable of demonstrating roughly the respiratory excursions of the lung margins, is hardly exact enough to determine the lowest inspiratory extent of the tapering lung margins. Consequently there is no agreement as to whether the lungs completely fill the costodiaphragmatic recesses in deepest inspiration.

In addition to the respiratory phase, the following factors influence the position of the inferior pleural and pulmonary boundaries: age, constitutional factors, and posture. During the life span of the individual the diaphragm, and with it the pleural sac and the lungs, is subject to a general descent. The quasi-normal emphysema of old age leads to an additional lowering of the inferior lung margins. Constitutional differences are likewise responsible for variations. The thoracic viscera are low in the slender, asthenic individual, while the diaphragm is high and the lungs are short in the hypersthenic type. With change in posture there also occurs a change in the position of diaphragm and thoracic viscera. The inferior pleural and pulmonary margins are lower in the standing than in the supine position. In the prone posture the diaphragm and the thoracic viscera are displaced upward by pressure from the abdominal viscera.

Sufficient roentgenographic information on the inferior pleural and pulmonary margins has been accumulated during the last ten years (Ottonello,²⁹ Bársony and Koppenstein,³ Peltason and Neumann,³¹ Korol,¹⁷ Lachman²¹) to regard the boundaries given in the anatomical literature with reservation, as far as the living individual is concerned. As a matter of fact, these margins are more commonly seen on the roentgenogram than the previously discussed mediastinal boundaries. In our own material they were demonstrable in approximately 15 per cent as an incidental finding in the study of the abdominal viscera. Consequently they were usually visible with the

subject in the prone position and with the roentgen rays traversing the body in dorso-ventral direction. In this projection we often find a line running horizontally or with medial ascent or upward concavity from the lateral thoracic wall toward the spinal column at any level from the upper margin of the twelfth thoracic vertebra to the lower margin of the second lumbar vertebra (Fig. 11 and 12). Adjacent to the lateral contour of the spinal column the line takes an upward turn and can be traced in its vertical course for several vertebrae. In combination with the cupola of the diaphragm cranial to it the line circumscribes a translucent space of oval shape in which lung markings can be observed. The latter can be seen extending down close to the line under discussion, but never beyond it. On bronchograms the lowest extent of the bronchial filling also corresponds in form and position to the line (Korol¹⁷). The anatomical substrate of this line is the posterior costodiaphragmatic reflection of the pleura, while the medial and upward extent of the line represents the lowest portion of the posterior mediastinal pleura. The oval space just described corresponds to that part of the lower lobe of the lung which is located behind the dome of the diaphragm.

The prone position and the inspiratory phase are especially favorable for visualization of the line and space, since the posterior portions of the lungs are then maximally aerated and attain their greatest expansion into the costodiaphragmatic sinus, thus producing conditions of optimal contrast. Yet our own roentgenographic material which was taken in arrest of quiet breathing showed the pleural line and the adjacent pulmonary translucency in approximately 15 per cent of all abdominal cases.

The line under discussion is subject to wide variations in form and position. Figures 11 and 12 illustrate these variations in normal cases taken from our own material. Each of the lines in Figure 12 represents one or more cases in which the pleural

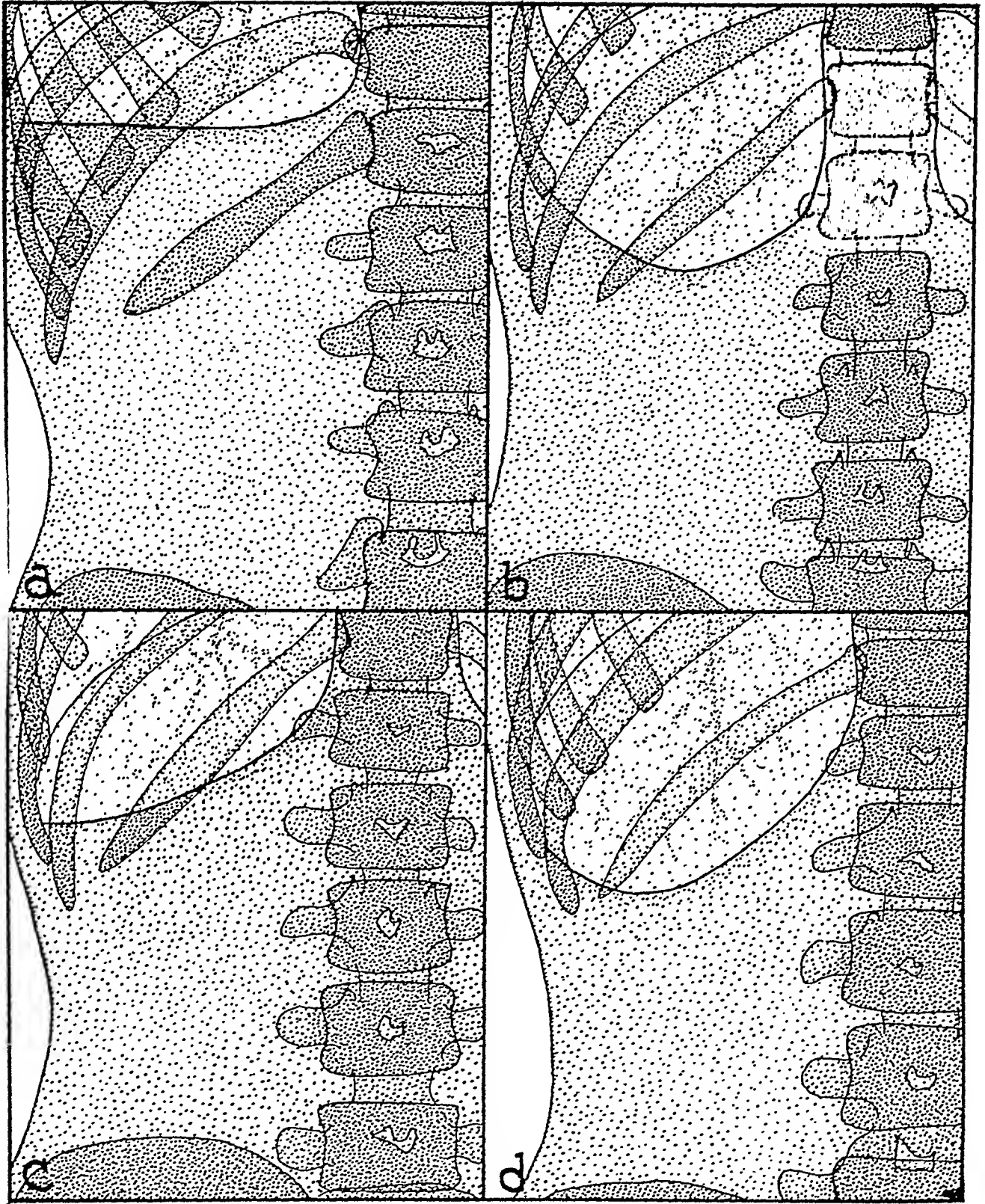


FIG. 11. Diagrams after roentgenograms of the right hypochondriac region. Observe the horizontal course of the pleural line in *a*, its medially ascending direction in *c*, and its upward concavity in *b* and *d*. The level of the line corresponds to the upper margin of the twelfth thoracic vertebra in *a*, and to the lower margin of the second lumbar vertebra in *d*. (From Lachman.²¹) (Reproduced by permission from *Anat. Rec.*, 1942, 83, 521-542.)

line was clearly visible. Although the roentgenograms were all taken in the same respiratory phase and position, we notice a

wide range in the location of the line. In only 6 out of 46 cases does the line correspond to the pleural margin given in

Cunningham (Fig. 12, left side), and in only 3 to the one given in Morris. Particularly interesting is the upward concavity of the line which is rather common in our material, but which has not been mentioned at all in anatomical descriptions. Roentgenographically the pleural line is more commonly found on the right side. If it is visible on both sides, then its course and

tributed to them by anatomists. The frequently demonstrated upward concavity of lower lung margins and pleura has not been mentioned. The great normal variability in the shape and position of this pleural reflection is likewise worth noting, also its lowest possible extent in the neutral respiratory phase down to the level of the second lumbar vertebra. It is probable that

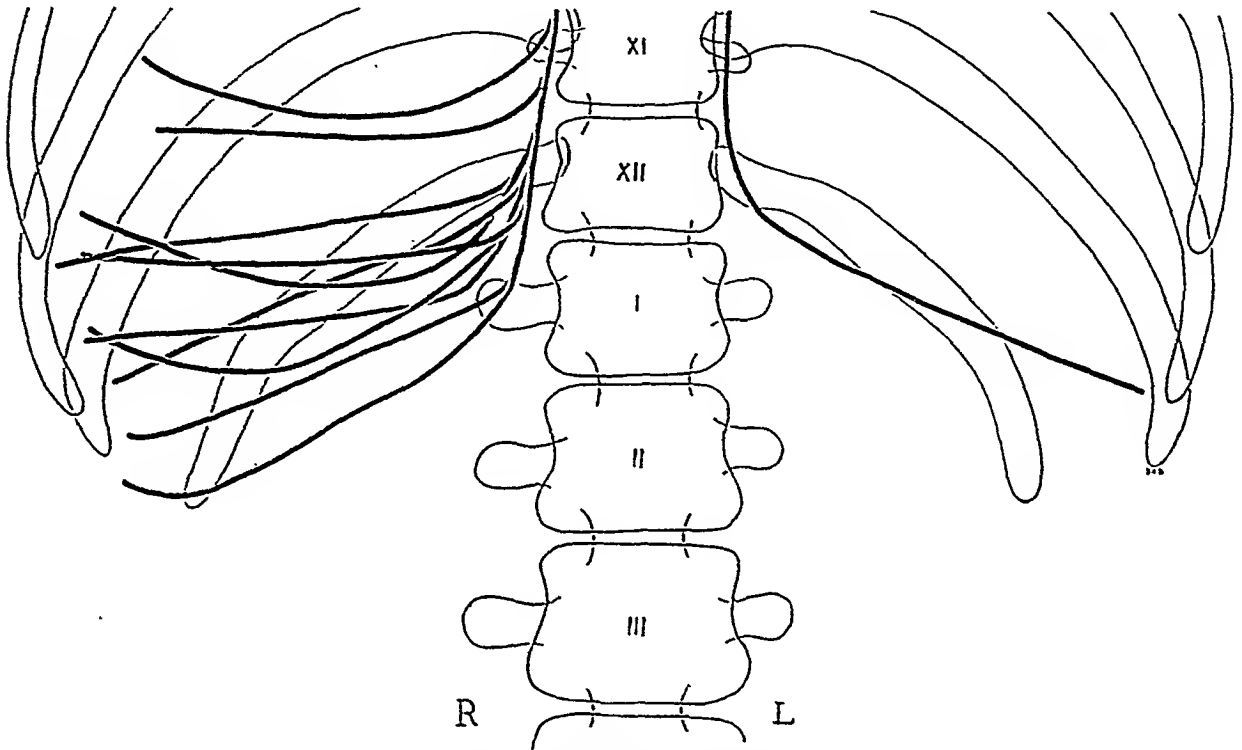


FIG. 12. Variations in the course of the pleural line according to roentgenograms in the prone position on the right; on the left the posterior inferior pleural reflection is drawn according to Cunningham.⁷

location are usually identical on the two sides.

The position of the line varies with the constitutional type of the individual, assuming its greatest concavity and lowest level in the asthenic individual (Fig. 11*d*). In cases where we were able to demonstrate the line in the supine position, the location did not differ essentially from that observed in prone subjects.

In comparing these roentgenographic findings with the descriptions in the anatomical literature we notice that the posterior inferior margins of the lungs and pleura of the prone and supine living subject usually reach a lower level than is at-

tributed to them by anatomists. The frequently demonstrated upward concavity of lower lung margins and pleura has not been mentioned. The presence of the pulmonary translucency and of lung markings in the previously described oval space proves that in the prone subject the lungs penetrate farther into the pleural sinus even in expiration than is generally assumed. For practical purposes, e.g., in operations on the prone patient, the possibility of the low extent of lung and pleura must be kept in mind to avoid inadvertent opening of the pleural cavity with resulting collapse of the lung and the unnecessary exposure of the pleura to infection.

CONCLUSIONS

The preceding examples chosen from different fields of thoracic anatomy have proved sufficiently that the topographic concepts of conventional anatomy do not cover adequately the wide range of the normal as revealed by roentgenographic exploration. These normal variations are the expression of alterations in the physiological state of the body or are due to differences in the constitutional make-up of individuals. The static and rigid surface anatomy of our present textbooks including those dealing with physical diagnosis should be replaced by a more flexible approach that takes account of this variability. The position of thoracic organs in the cadaver differs in many respects from that found in the living and cannot serve as a proper norm for clinical purposes. The study of the surface relationship of the thoracic viscera in the cadaver seems therefore of questionable value and should be replaced, wherever possible, by roentgenographic investigation in the living. Roentgenographic study of the topography of the thoracic organs, although still in its beginning and laboring under many handicaps, has already proved its value in the determination of the surface relationship of the trachea, the heart, and the posterior pleural and pulmonary boundaries.

The shape of the posterior mediastinum in the upright individual deviates apparently from the customary accounts of its anatomy. The contents of the subdivisions of the mediastinum in the erect subject do not coincide completely with those found in the supine cadaver. Thus the bifurcation of the trachea and the arch of the aorta may be located below the dividing line of the superior and inferior mediastinum instead of in the superior mediastinum where our textbooks place it.

The concept of the upright posture as "the anatomical position" is not consistent with the topographical descriptions of our texts and therefore should not be retained at the present time. It might be reintroduced after sufficient roentgenographic

data on the shape and position of the viscera in the upright living individual have been collected. For the time being, the concept of the anatomical position might profitably be discarded and positional terms such as superior, inferior, anterior, and posterior could be replaced by designations such as cranial, caudal, ventral, and dorsal, that do not relate to any particular position of the body. If it seems impossible to abolish such time honored terms as superior vena cava and inferior lobe of the lung, attention should be called to the fact that these designations do not imply a vertical position of the body as far as conventional topographical descriptions are concerned.

SUMMARY

1. Since roentgen studies on the topographic anatomy of the abdominal viscera in the living have proved that their position is extremely variable and that the conventional fixed relationships of the organs pertain only to the cadaver, similar investigations on the thoracic viscera are indicated, but only few have been undertaken so far.

2. According to anatomical teaching the bifurcation of the trachea is placed at the level of the intervertebral disc between the fourth and fifth thoracic vertebra. But roentgenography reveals that in the upright adult subject it is usually considerably lower. The bifurcation is at its highest level during earliest infancy and then participates in the general descent of the viscera which takes place during the life span of the individual. Contrary to anatomical teaching the bifurcation of the trachea is not fixed, but undergoes a respiratory shift.

3. Many factors contribute to make the configuration of the heart extremely variable in the living; foremost among these is the position of the diaphragm which is influenced by respiration, body posture, the state of filling of the abdominal viscera, fat content of the abdomen, etc. Other factors responsible for variations are the constitutional type of the individual, the age

and sex, weight and height, and the cardiac phase and pulse rate.

4. In view of the variability of cardiac configuration the introduction of a single scheme as the standard surface projection of the heart appears of questionable value. But if for didactic purposes a single schematic representation is desired, it should not be based on conditions in the cadaver, but on roentgen studies in the living, with particular attention to respiratory, postural and pulsatory changes in cardiac configuration.

5. Mainland and Gordon²⁵ have collected sufficient data on the surface projection of the heart in the living to compare it with conventional textbook descriptions. This comparison reveals considerable differences. The heart in the erect living subject lies much lower than usually assumed. Particularly surprising is the location of the inferior cardiac border, which is given as crossing the midline 4.5 centimeters below the xiphisternal joint. The heart of the recumbent living subject approximates the cadaveric position, but still does not lie as far cranial as the latter.

6. Results of roentgenographic studies on posterior mediastinal and posterior inferior boundaries of lungs and pleura in the living are likewise not in complete agreement with conventional anatomical teaching. According to the latter the lungs and pleural cavities are separated posteriorly by a wide mediastinal space in which the esophagus is located directly in front of the spinal column. In contrast to this, roentgenograms occasionally depict the presence of a prevertebral space which is occupied by lung and pleura. The posterior inferior pleural reflection is characterized roentgenographically by a line running horizontally or with medial ascent or upward concavity from the lateral thoracic wall toward the spinal column at any level from the twelfth thoracic to the second lumbar vertebra. A translucency cranial to it is produced by inferior lung portions located behind the dome of the diaphragm. Anatomical presentations usually place the

inferior pulmonary and pleural boundaries higher and disregard the commonly found upward concavity of the pleural reflection.

7. These examples from the field of mediastinal and pleuropulmonary anatomy prove sufficiently that the topographic concepts of conventional anatomy do not cover adequately the wide range of the normal as revealed by roentgenographic exploration. A more flexible approach is necessary that takes account of this variability. The position of the thoracic organs in the cadaver cannot serve as a proper norm for clinical purposes. As far as topographical anatomy is concerned, studies on cadavers should be replaced, wherever possible, by roentgenographic investigation in the living, which has already proved its value.

8. The concept of the upright posture as "the anatomical position" is not consistent with the topographical descriptions of our texts and can hardly be retained at the present time. It might be reintroduced after sufficient roentgenographic data on the surface relationship in the upright living subject have been collected. Positional terms presupposing a definite posture could be replaced by designations that do not relate to any particular position of the body.

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REFERENCES

1. ADDISON, C. On the topographical anatomy of the abdominal viscera in man, especially the gastro-intestinal tract. *J. Anat. & Physiol.*, 1898-1899, 33, 565-586; 1899-1900, 34, 427-450; 1900-1901, 35, 166-204.
2. BARCLAY, A. E. The Digestive Tract. A Radiological Study of Its Anatomy, Physiology, and Pathology. Cambridge, 1936.
3. BÁRSONY, T., and KOPPENSTEIN, E. Das sagittale Röntgenbild des rechten hinteren Pleurasinus und pathologische Veränderungen desselben. *Röntgenpraxis*, 1933, 5, 170-173.
4. BÁRSONY, T., and WALD, B. Das Röntgenbild der oberen hinteren schwachen Stelle des Mediastinums. Der prävertebrale, retroösophageale Lungenteil. *Röntgenpraxis*, 1936, 8, 88-95.
5. BÁRSONY, T., and WALD, B. Die normale Trachea im sagittalen Röntgenbilde, Medi-

- astinumstudien. *Röntgenpraxis*, 1937, 9, 164-180.
6. BRAILSFORD, J. F. Radiographic postero-medial border of the lung, or the linear thoracic paraspinal shadow. *Radiology*, 1943, 41, 34-37.
 7. CUNNINGHAM, D. J. Text-book of Anatomy. Eighth edition. Oxford University Press, New York and London, 1943.
 8. DANIELIUS, G. Röntgenologie der oberen medialen Lungenabschnitte. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1931, 44, 626-634.
 9. DANIELIUS, G. Zur Frage der "pleuritischen Mediastinalstreifen." *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, 47, 271-275.
 10. DIETLEN, H. Herz und Gefäße im Roentgenbild. Leipzig, 1923.
 11. ENGEL, S. Anatomie und Topographie der Luftwege in "Handbuch der Röntgendiagnostik und -Therapie im Kindesalter." Edited by Engel, S., and Schall, L., Leipzig, 1933.
 12. GARLAND, L. H. Postero-mesial pleural line. *Radiology*, 1943, 41, 29-33.
 13. GRANT, J. C. B. A Method of Anatomy. Third edition. The Williams & Wilkins Co., Baltimore, 1944.
 14. GROEDEL, F. M. Lehrbuch und Atlas der inneren Medizin und ihren Grenzgebieten. München, 1936.
 15. HEISS, R. Ueber die hinteren Pleuragrenzen. *Arch. f. Anat. u. Physiol., Anat. Abt.*, 1919, 130-136.
 16. KÖHLER, A. Röntgenology. Second English edition. Translated and edited by Arthur Turnbull. William Wood & Co., Baltimore, 1935.
 17. KOROL, E. The lower lung line. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1935, 34, 740-743.
 18. KREUZFUCHS, S. Die Bifurkation der Trachea in Konstitution und Pathologie. *Fortschr. a. d. Geb. d. Röntgenstrahlen* (Tagungshft), 1937, 56, 22-24.
 19. KUDISCH, B. M. Röntgenologische Studien der Aorta. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, 48, 298-306.
 20. KURTZ, C. M. Orthodiascopy: An Analysis of over Seventeen Hundred Orthodiascopic Examinations. Macmillan Co., New York, 1937.
 21. LACHMAN, E. Comparison of the posterior boundaries of lungs and pleura as demonstrated on the cadaver and on the roentgenogram of the living. *Anat. Rec.*, 1942, 83, 521-542.
 22. LUBOSCH, W. Outlines of Scientific Anatomy. London, 1928.
 23. MACKLIN, C. C. The dynamic bronchial tree. *Am. Rev. Tuberc.*, 1932, 25, 393-417.
 24. MAIER, H. C. Roentgen aspects of the upper retro-esophageal pulmonary borders. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 43, 168-172.
 25. MAINLAND, D., and GORDON, E. J. Position of organs determined from thoracic radiographs of young adult males, with a study of the cardiac apex beat. *Am. J. Anat.*, 1941, 68, 457-496.
 26. MOODY, R. O. Position of the abdominal viscera in healthy young British and American adults. *J. Anat.*, 1927, 61, 223-231.
 27. MOODY, R. O., and VAN NUYS, R. G. Some results of a study of roentgenograms of the abdominal viscera. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1928, 20, 348-358.
 28. MORRIS, HENRY. Morris' Human Anatomy. Ninth edition, edited by C. M. Jackson; tenth edition, edited by J. Parsons Schaeffer. Blakiston Co., Philadelphia, 1933 and 1942.
 29. OTTONELLO, P. Bemerkungen zur normalen Röntgenanatomie des Thorax. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1932, 45, 677-687.
 30. OTTONELLO, P. La rappresentazione radiografica dello sfondato pleurico posteriore. *Radiol. med.*, 1932, 19, 469-476.
 31. PELTASON, F., and NEUMANN, W. Die Röntgendarstellung der unteren Pleuragrenze. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, 47, 519-529.
 32. PRATJE, A. Zur Topographie des Mediastinums am Lebenden. *Anat. Anzeiger*, 1924, 58, Erg. Heft, 89-99.
 33. ROESLER, H. Clinical Roentgenology of the Cardiovascular System. Second edition. Charles C Thomas, Springfield, Ill., 1943.
 34. STÉPHANI, J., and KIRSCH, R. Étude radiographique de l'expansion interne du poumon droit; condition nécessaire pour qu'elle se réalise et que son image radiographique apparaisse. *Presse méd.*, 1936, 44, 1585-1586.
 35. ZDANSKY, E. Röntgendiagnostik des Herzens und der grossen Gefäße. J. Springer, Wien, 1939.



PORENCEPHALY*

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PORENCEPHALY is the occasional end point of many disease processes.

Since the term porencephaly was first used, it has been variously defined. Perhaps the most widely accepted definition is that of LeCount and Semerak¹¹ who describe "a defect communicating with the ventricles or separated from them by a thin layer of brain tissue, and covered on the outside by the arachnoid." Others¹⁹ believe that, roentgenologically, any defect communicating with a ventricle and appearing in the tissues may be considered a porencephaly.

Porencephaly may be broadly classified as developmental or acquired in origin. The developmental defect may be the result of gene abnormalities or injury of the germ plasm before fertilization.¹⁰ LeCount and Semerak¹¹ and Eisenstein and Taylor⁵ believe congenital vascular defects may cause porencephaly. The acquired factors which may be etiologically significant are somewhat interrelated and may appear in intrauterine life,² at birth,¹⁰ in post-natal,²¹ and in later life.¹⁸ They may be classified as traumatic, vascular, and inflammatory. Jaffé⁹ believes that trauma is the most important causative agent. He stresses the importance of the secondary circulatory disturbances in the large veins due to backing up of blood in the venous sinuses. Vascular accidents such as hemorrhage, embolism and thrombosis may lead to porencephaly. This has been observed experimentally⁶ as well as clinically.^{13,15} Globus⁸ believes that endarteritis and thrombosis are the predominant causative factors in porencephaly resulting from meningo-encephalitis. Penfield¹⁶ has observed constriction of large pial arteries capable of arresting blood flow after convulsions in habitual epilepsy. He believes that focal atrophy and porencephaly may

result from repeated episodes of localized vascular spasm. He further believes that convulsive episodes occurring in children with acute febrile illnesses may be caused by cerebral thrombosis secondary to severe dehydration. Localized atrophy and porencephaly may then result. Inflammatory lesions such as tuberculosis,²² syphilis,¹¹ and encephalitis have been described as underlying causes of porencephaly. The very multiplicity of possibilities in many instances makes it difficult to establish the underlying cause. The etiology was not definitely determined in 17 of the 29 cases herein reported. Wilson,²¹ distinguishing the true or developmental porencephaly from the acquired, says the acquired type is cystic rather than crateriform, does not always lead to ventricular fenestration, may contain yellowish albuminous fluid and is not lined by smooth gyral formation, but by a membranous wall adherent to the white matter of the centrum semiovale. Jaffé⁹ believes that a porencephaly formed in the immature brain may be differentiated from that in the mature organ by the lack of mesenchymal proliferation in the wall of the cyst formed in immature tissue. Sixteen of our 29 cases were operated upon or autopsied and none of them fulfilled all of Wilson's criteria for the developmental type or "true" porencephaly. Five of the cases were apparently caused by intrauterine or birth injuries, 3 by trauma later in life, and 2 by encephalitis.

Porencephaly is a condition which must be considered in the differential diagnosis of mass or contracting lesions involving the brain. Occasionally it is confused with other cystic lesions clinically, roentgenologically and even microscopically. Since porencephaly is a benign condition, its recognition is important in determining prognosis and therapy. De Sanctis and his

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co-workers⁴ believe "the necessity for clinical diagnosis cannot be overemphasized, for it leads to both confirmatory diagnostic procedures and treatment, the latter alleviating the condition entirely or in part."

Our series consists of 29 cases of porencephaly. All were studied by encephalogra-

bility, sluggishness, and excitability. In studying the psychiatric aspects of porencephaly, Bernstein¹ found poor social and sexual adjustment, sluggishness, feelings of inadequacy, deficient powers of generalization, and inability to concentrate in most of his patients. He believed the only possible difference from the usual epilep-

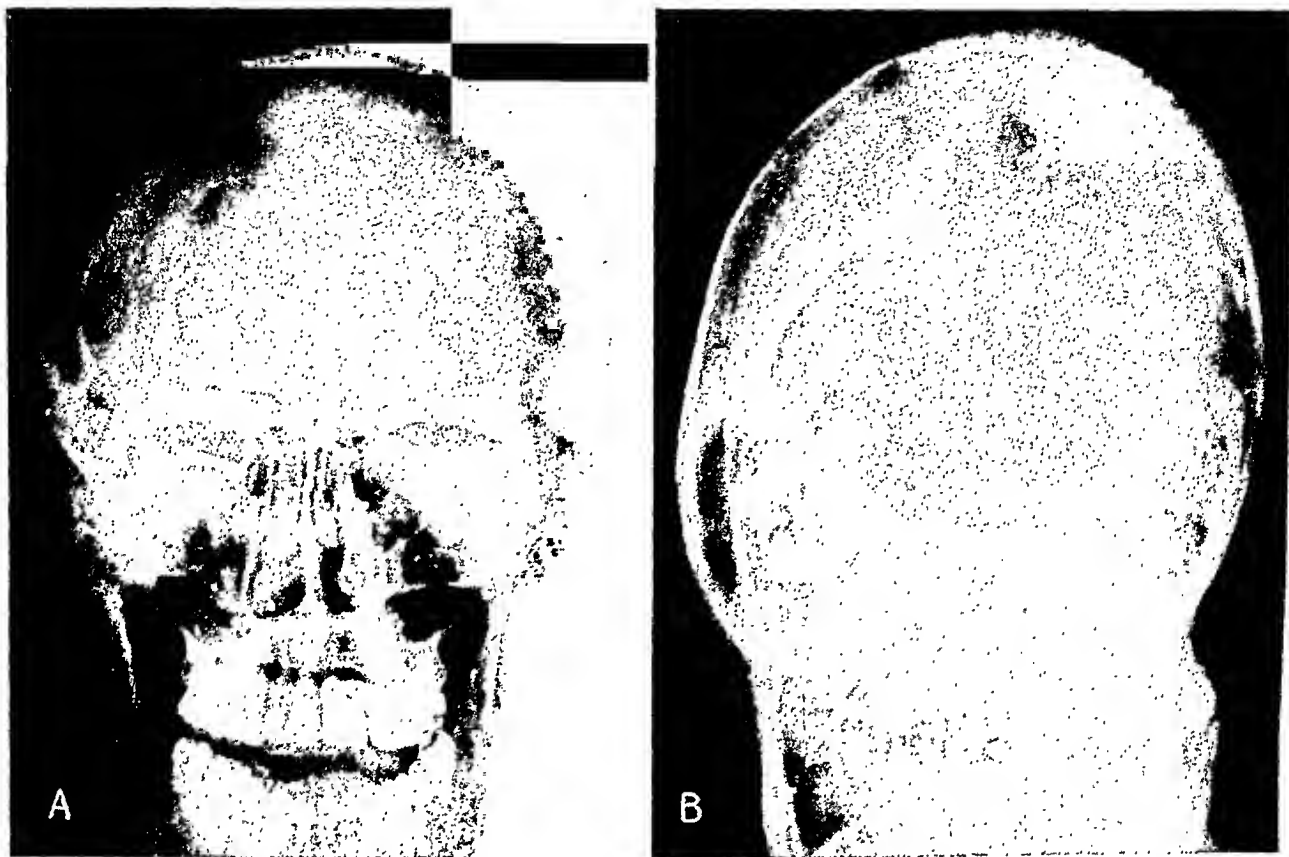


FIG. 1, *A* and *B*. Conventional roentgenograms of a male patient, aged thirty with an extensive porencephaly of the right hemisphere causing thinning of the inner table of the vault and disappearance of the diploic space on the right side. These changes were thought to result from an atrophy produced by transmitted pulsation through the fluid in the porencephaly from the ventricular system with which it communicated. The under development of the right side likewise resulted from the porencephaly.

phy or ventriculography and 16 were subjected to craniectomy.

The average age of the patients was sixteen, the oldest being thirty-four years and the youngest nine months. The duration of symptoms varied from three months to lifetime (thirty years). Most patients (26) sought medical attention because of epileptic attacks, which usually had been preceded for several years by other symptoms such as weakness of an extremity, strabismus, or mental retardation. Others complained of headache, poor memory, irrita-

tics would be the inability to concentrate and the deficient powers of generalization. The psychiatric picture did not differ greatly from some syphilitic, encephalitic and neoplastic patients.

Sixteen of the series had paresis or paralysis of one or two extremities and 2 of these had facial paralysis as well. Atrophy or hypodevelopment of one-half of the body or the involved extremity was present in those who had had paralysis since early childhood. Occasionally anesthetics were present. The importance of the

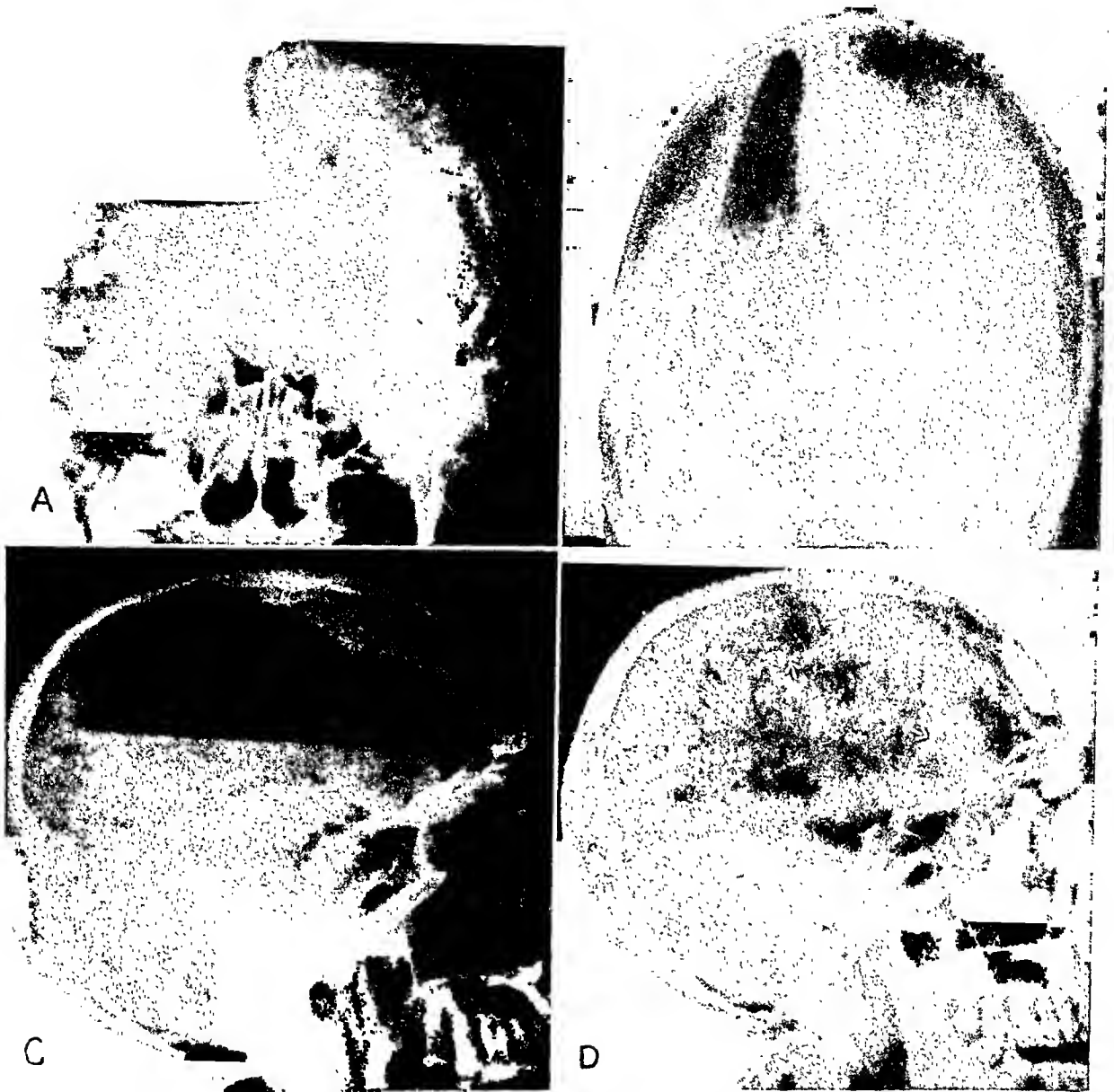


FIG. 2, *A, B, C, D.* Encephalogram of the same patient as shown in Fig. 1, *A* and *B*. These illustrations show a tremendous porencephaly with very little air in the ventricular system and subarachnoid pathways because of incomplete drainage of the cerebrospinal fluid. In (*A*), the posteroanterior view, the falx is shifted to the right; in (*B*), the anteroposterior view, the falx is displaced; in (*C*), the erect lateral view, the fluid level is seen readily and in (*D*), the horizontal lateral view, the extent of the porencephaly can be appreciated. In (*D*) arrows are directed at what may be septa in the cyst.

latter has been stressed in clinical differentiation from Little's disease.¹³ Papilledema was present in 3 patients so that a tumor was suspected clinically. Four had homonymous hemianopsia and 1 bitemporal hemianopsia. Peripheral constriction of the visual fields was noted in 1 patient. Patten, Grant and Yaskin¹³ describe a "complete syndrome" which they believe is clinically indicative of a porencephalic cyst.

It consists of failure of development of one-half or part of one-half of the body, accompanied by motor neuron weakness, sensory disturbances, and jacksonian fits. If the cyst is in a silent area, there may be no symptoms¹⁹ and there are usually relatively few symptoms when one considers the size of the cysts which would often seem incompatible with life. One of our cases, who had no paresis or paralysis and

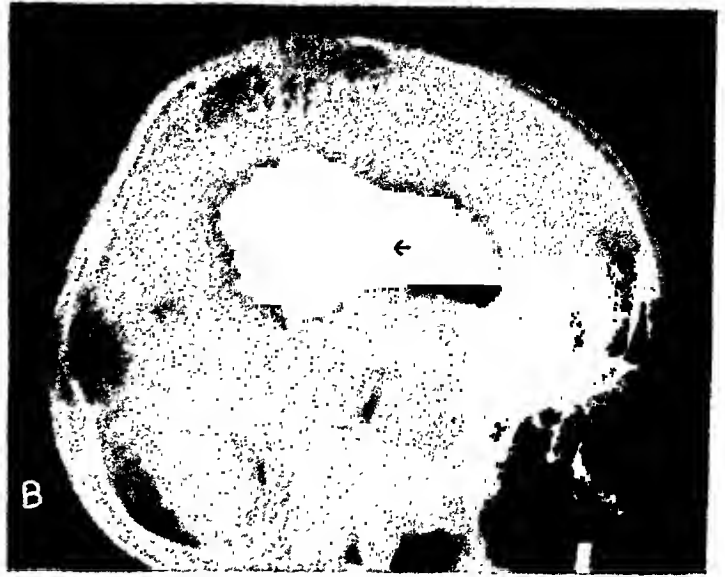
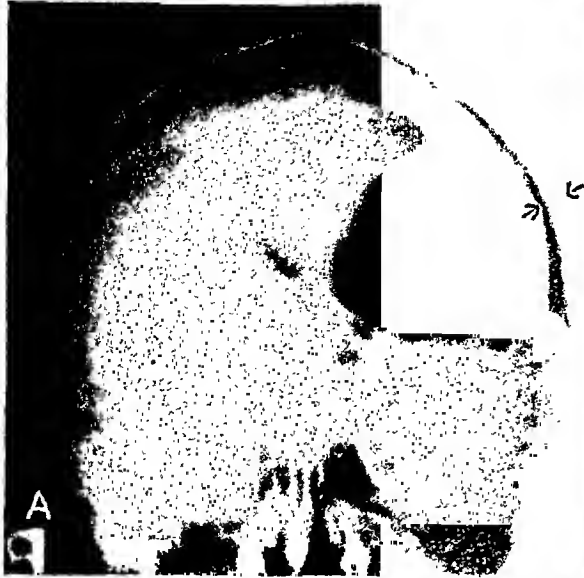


FIG. 3, *A* and *B*. An encephalogram of a male patient, aged fourteen, illustrating a left parietal lobe porencephaly with thickening of the skull in the region of the cyst. In both views the cyst is incorporated in or participated in formation of the shadow of what seems to be an enlarged left ventricle.



complained only of convulsions and diminution of vision, was found to have an extensive porencephaly involving the entire left hemisphere. Nevertheless, as would be expected, the symptoms are to a large extent dependent upon the location of the lesion. Sixteen of this series were left sided, 12 were on the right, and 1 was bilateral. Penfield and Erickson¹⁷ believe the parietal and temporal regions to be the most common site. According to Jaffé,⁹ the parietal region is especially exposed to birth injuries. We found the parietal region to be involved wholly or to some extent in 69 per cent, the frontal lobes in 52 per cent, and the occipital lobes in 26 per cent. Three of the patients had more than one cyst.

Conventional roentgenograms may be negative in porencephaly, but more often some degree of asymmetry is evident. The most common finding is a change in the

FIG. 4, *A* and *B*. Small porencephaly in a female child aged two years with extensive internal hydrocephalus.

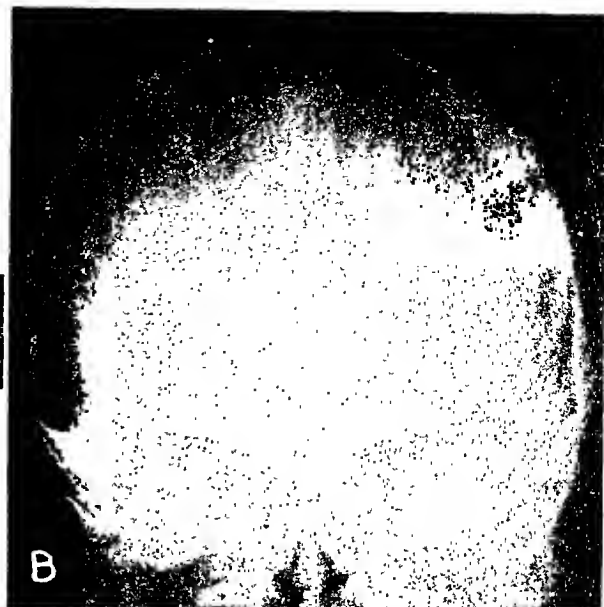


FIG. 5, *A, B, C.* (above and left) Craniostenosis in a one year old boy who has porencephaly. All of the sutures are closed except some of those in the occiput and base, see (*A*) and (*C*).

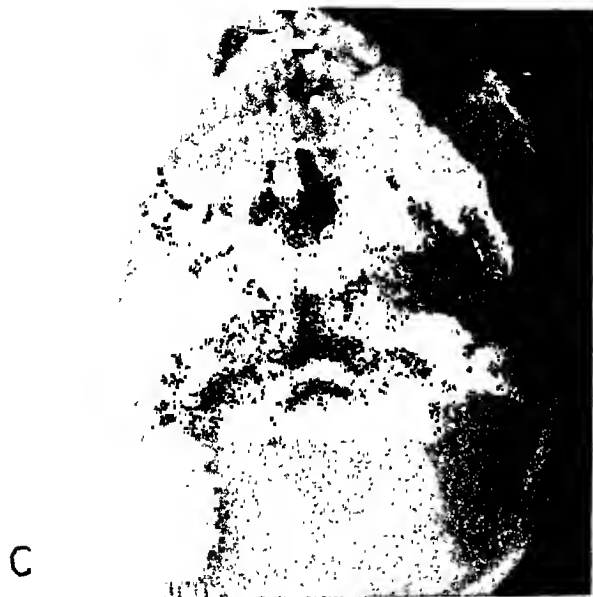


FIG. 6, *A and B.* (below) Encephalogram in same case as Figure 5. In (*A*) the vault in the affected side is below the level of the other. One wonders whether this may account for the apparent midline shift to the left which is so unusual in an atrophic lesion. The absence of subarachnoid pathways is explained on the basis of arachnoiditis.



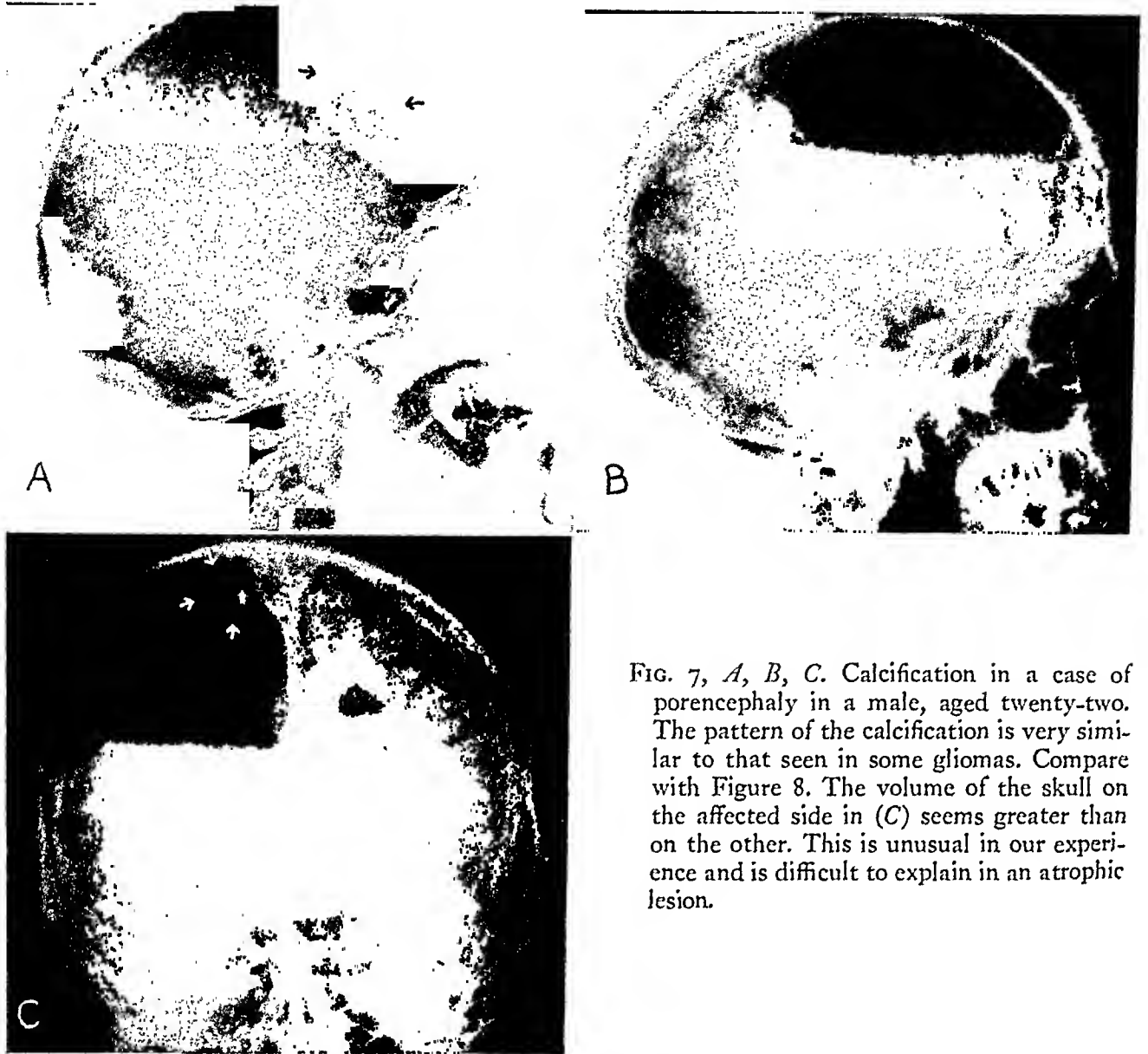


FIG. 7, *A, B, C.* Calcification in a case of porencephaly in a male, aged twenty-two. The pattern of the calcification is very similar to that seen in some gliomas. Compare with Figure 8. The volume of the skull on the affected side in (*C*) seems greater than on the other. This is unusual in our experience and is difficult to explain in an atrophic lesion.



FIG. 8. A male patient, aged forty-six years with calcification in an astrocytoma. Compare with calcification which occurred in patient with porencephaly in Figure 7*A*.

thickness of the skull on one side. This change is usually somewhat localized but may be generalized. Fifteen of this series had some degree of thinning on the side of the lesion (Fig. 1 and 2). The thinning consisted of a localized atrophy in 1 instance (Fig. 13). There was no demonstrable difference in 4 cases, but in 7 the bones were thicker on the homolateral side (Fig. 3). This variation is readily explained in some instances yet in others where similar conditions seem to obtain such an explanation may not be satisfactory. For instance, in those cases with thinning, and in which the cyst is usually in contact with the calvarium and communicating with the ventricle, it is possible for the pulsating intra-

ventricular pressure to be transmitted to the vault through the fluid in the cyst which lies against the bone (Fig. 1 and 2). In cases like that shown in Figure 3, the vault is thicker on the affected side yet the air shadow is adjacent to the bone. Our explanation in this instance is that the atrophic and contracting manifestations of

pyramid, mastoid and frontal and ethmoid sinuses, any or all of which may be present on the side of the porencephaly. Similar observations have been made by Davidoff and Dyke³ in chronic relapsing subdural hematoma. Thus, if the element of atrophy predominates, there may be homolateral thickening of the bones but it does not

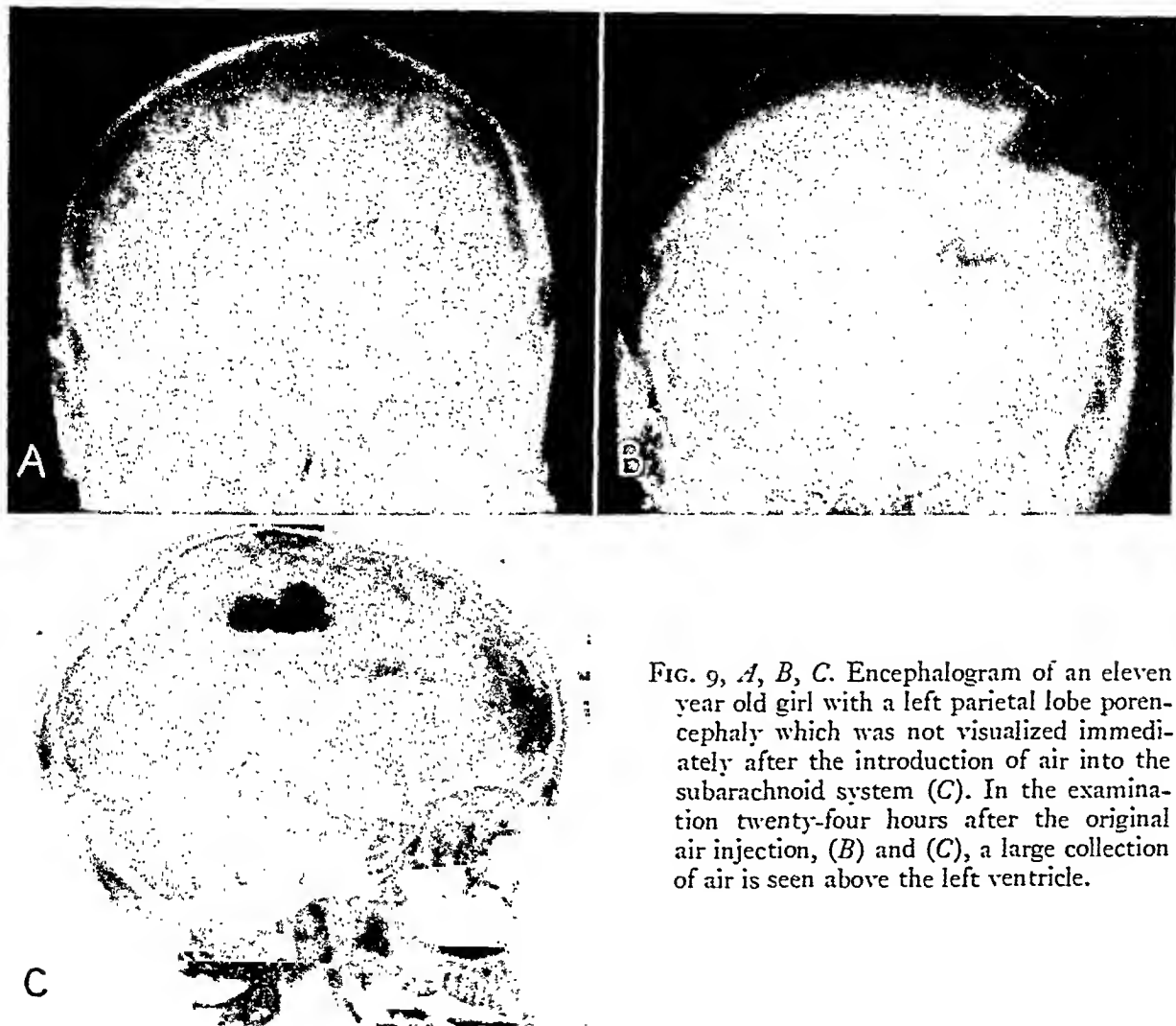


FIG. 9, A, B, C. Encephalogram of an eleven year old girl with a left parietal lobe porencephaly which was not visualized immediately after the introduction of air into the subarachnoid system (C). In the examination twenty-four hours after the original air injection, (B) and (C), a large collection of air is seen above the left ventricle.

the process (porencephaly) are in preponderance and have thereby stimulated overgrowth of bone.

Porencephaly is a manifestation of atrophy and it may be the underlying lesion in hemiatrophy or underdevelopment. In such a case, the cranial vault on the affected side may be smaller, and there may be a *thickening or compensatory hypertrophy of the bones, elevation of the petrous ridge, and increased pneumatization of the petrous*

mean necessarily that other manifestations of hemiatrophy will be present. Slightly more than 50 per cent of the series had no variation in skull volume. The volume of the skull on the side of the lesion was definitely less in 6 cases. A significantly greater volume was noted in only 1 case (Fig. 7).

Occasionally in patients with porencephaly one may find a co-existing hydrocephalus or craniostenosis (Fig. 4, 5 and 6). If the pineal is calcified, it is more often

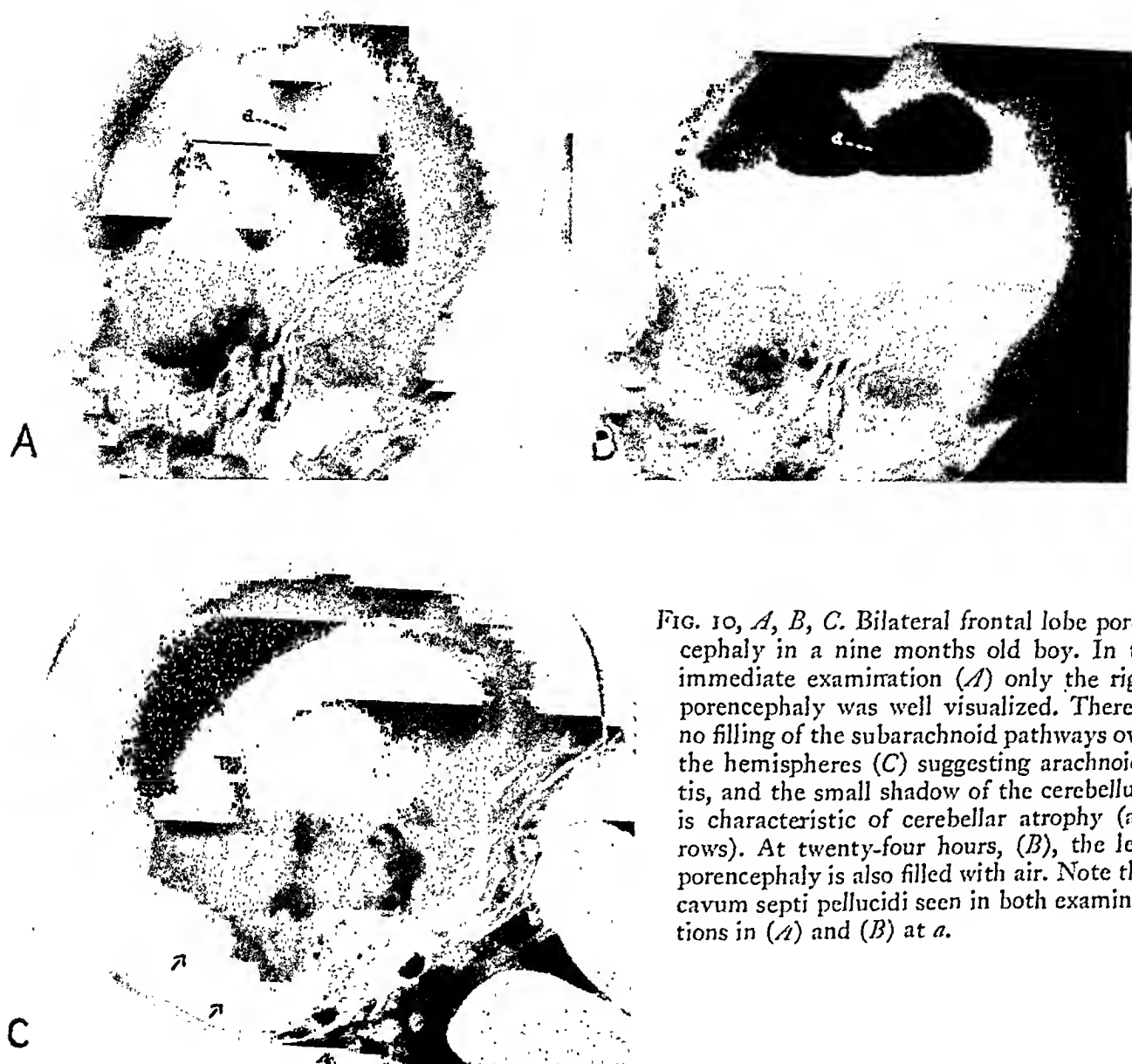


FIG. 10, *A, B, C*. Bilateral frontal lobe porencephaly in a nine months old boy. In the immediate examination (*A*) only the right porencephaly was well visualized. There is no filling of the subarachnoid pathways over the hemispheres (*C*) suggesting arachnoiditis, and the small shadow of the cerebellum is characteristic of cerebellar atrophy (arrows). At twenty-four hours, (*B*), the left porencephaly is also filled with air. Note the cavum septi pellucidi seen in both examinations in (*A*) and (*B*) at *a*.

but not always slightly displaced toward the side of the lesion because of the accompanying cerebral atrophy. Furthermore, there may also be *calcification* in the region of the porencephaly. This has not been previously reported but in 1 of our cases, there was a *calcification not unlike that seen in gliomas* (Fig. 7 and 8).

A definite diagnosis of porencephaly can be made only by the use of encephalography or ventriculography and since the development of these two procedures, what was thought to be a rare condition is found much more frequently. Encephalography also may demonstrate accompanying

changes such as arachnoiditis (Fig. 6 and 10), convolutional atrophy (Fig. 16), enlargement of the basal cisternae (Fig. 11), and anomalies such as cerebellar atrophy (Fig. 10). Pendergrass and Hodes¹⁴ have demonstrated the value of the twenty-four hour examination in showing porencephaly not evident in the roentgenographic examination immediately following the injection of the air into the lumbar subarachnoid space. An unsuspected porencephaly was discovered in 1 of our cases at twenty-four hours (Fig. 9), and an additional porencephaly in the opposite cerebral hemisphere was demonstrated in another (Fig.

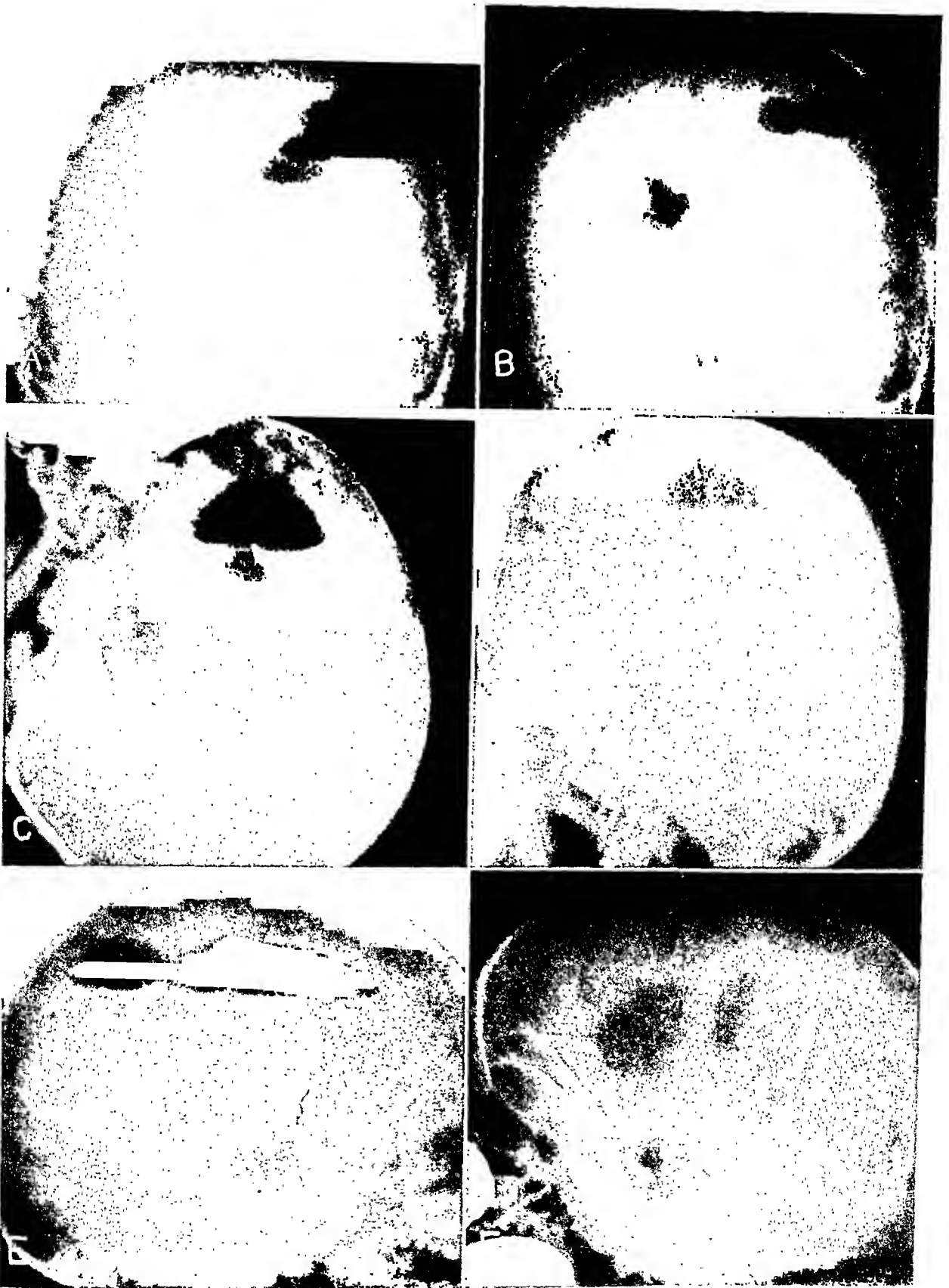


FIG. 11, *A, B, C, D, E, F.* (*A*) represents porencephaly in the left hemisphere in a nine months old boy. Only the left ventricle can be seen. In (*B*), examination twenty-four hour after (*A*), the right ventricle contains air. When the ventricular system is incompletely drained, roentgenograms obtained in the horizontal position, supine (*C*) and prone (*D*) assist greatly in determining the extent of the porencephaly. In (*E*) and (*F*), the basal cisternae in the region of the sella seem large. (*E*) was obtained in the erect posture and (*F*) in the horizontal. The absence of subarachnoid cortical air may be due to arachnoiditis or to incomplete drainage of fluid.

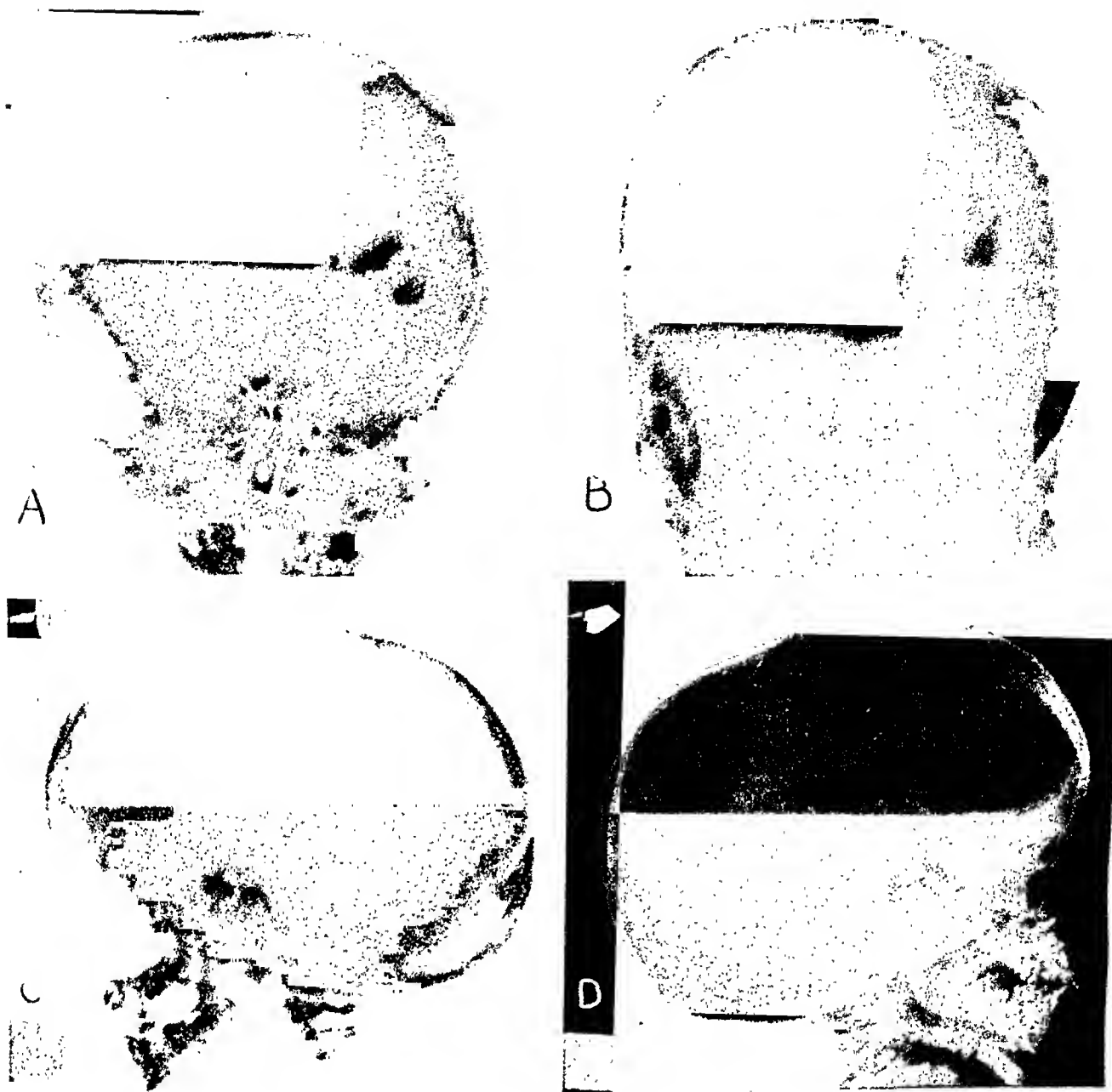


FIG. 12, *A, B, C, D.* A ventriculo-encephalogram in a twenty months old female child illustrating a large porencephaly replacing the right hemisphere. The various positions employed to demonstrate the walls of the porencephaly are shown.

(*A*) posteroanterior view; (*B*), anteroposterior; (*C*) right lateral, erect; (*D*) left lateral, erect.

10). Furthermore, if only one ventricle has been visualized initially, the opposite one may be filled in the twenty-four hour examination (Fig. 11).

Ventriculography is preferred in the occasional case with increased intracranial pressure. Occasionally the needle employed to drain the ventricles may enter a non-communicating porencephaly which otherwise may not be demonstrable by either encephalography or ventriculography.

It is often difficult to demonstrate satis-

factorily the true extent of the porencephaly, especially if there has been incomplete drainage of the cerebrospinal fluid prior to the injection of the air. Regardless of which air study is used, the examination should include the following positions as a minimum: (1) posteroanterior and anteroposterior views; (2) each lateral erect, stereo preferred; (3) each lateral in the prone position using a vertical beam; (4) a single lateral in the supine position (brow up) and a single lateral in the prone position

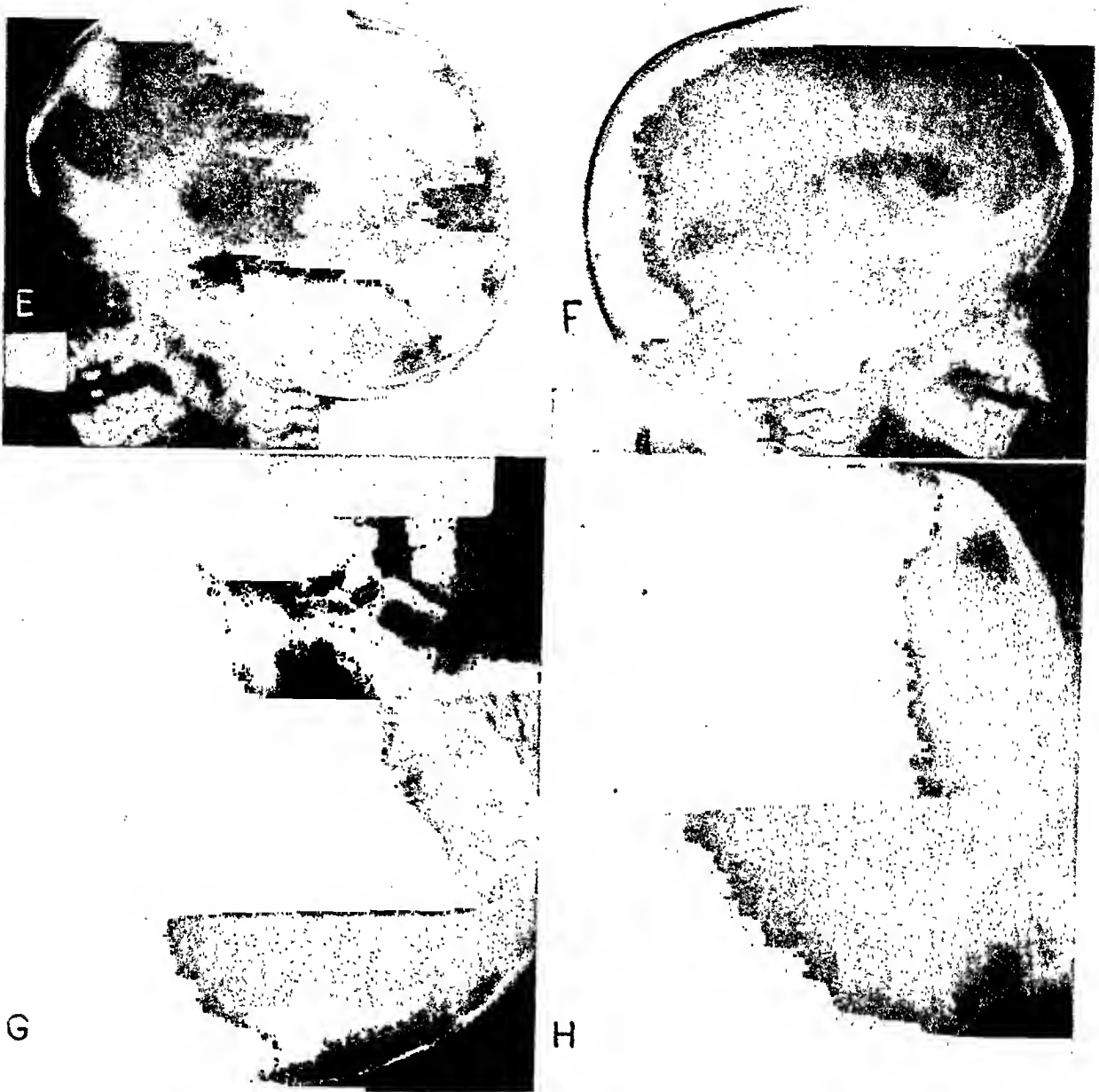


FIG. 12, *E, F, G, H.* (*E*) right lateral, horizontal; (*F*) left lateral, horizontal; (*G*) lateral horizontal, supine; (*H*) lateral horizontal, prone.

(brow down) using a horizontal beam. If drainage is of necessity incomplete, further views may be necessary to outline the entire wall of the porencephaly and to demonstrate undrained daughter cysts in the porencephaly (Fig. 12, *A-K*). These are usually made in the posteroanterior projection using a horizontal beam with the patient lying on either side. Another posteroanterior and lateral should be made with the patient's head hanging downward (inverted position) to outline the floor of

the cyst (Fig. 12, *A-K*).

Roentgenologically, there are several types of porencephaly. The terms "lobe," "interlobe," and "hemisphere" porencephaly may be used as an anatomical classification indicating location and size. The majority of the porencephalies are either "lobe" (48 per cent) (Fig. 13, *A-B*), or "interlobe" (41 per cent) (Fig. 14, *A-B*), consisting of medium-sized and large cysts with smooth well demarcated walls. The exact location of the communication with

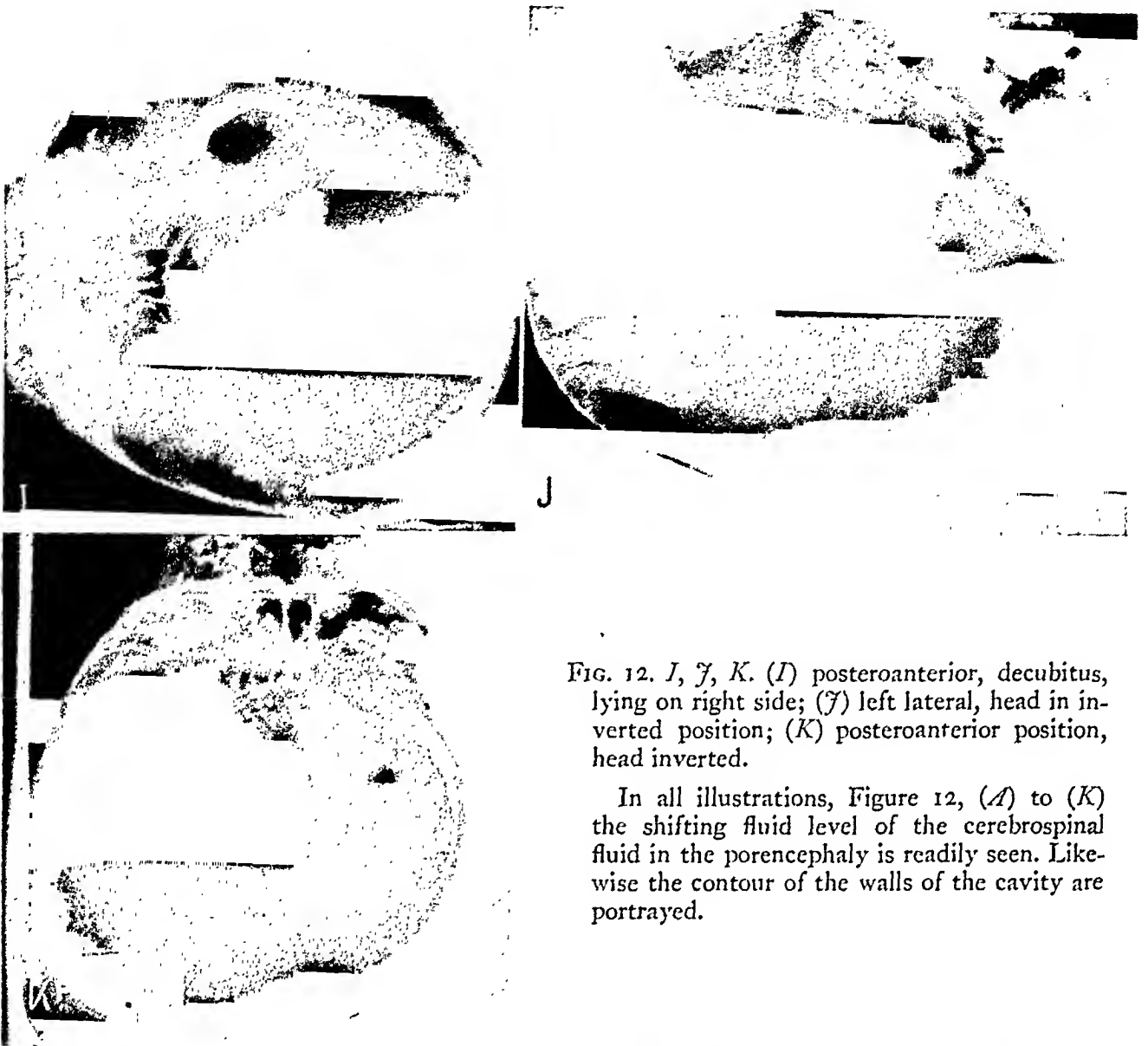


FIG. 12. *I, J, K.* (*I*) posteroanterior, decubitus, lying on right side; (*J*) left lateral, head in inverted position; (*K*) posteroanterior position, head inverted.

In all illustrations, Figure 12, (*A*) to (*K*) the shifting fluid level of the cerebrospinal fluid in the porencephaly is readily seen. Likewise the contour of the walls of the cavity are portrayed.

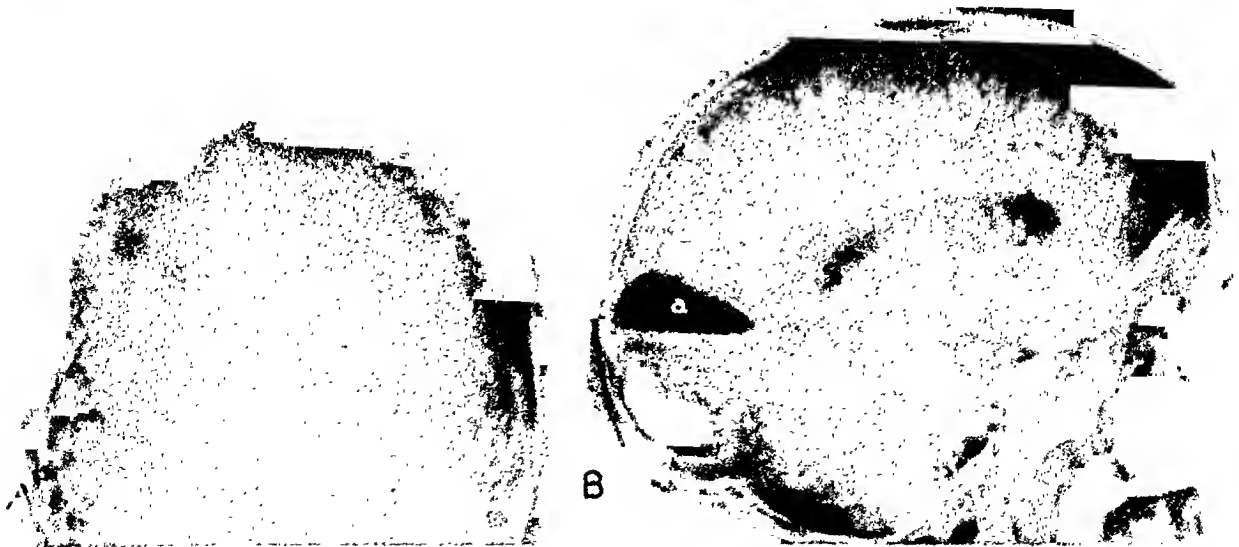


FIG. 13, *A* and *B.* Right occipital lobe porencephaly in a male aged nineteen years. In (*A*) the localized area of bone atrophy is seen in the occipital bone, overlying the porencephaly. In (*B*) the porencephaly communicates with the posterior horn of the lateral ventricle at *b*.

the ventricle is often difficult to demonstrate and may not be seen but if sufficient views are obtained one frequently can demonstrate its site (Fig. 14). Rarely, one may see a cluster of "daughter" cysts on the wall of the large "mother" cyst, simulating the nubbin of a cystic glioma, (Fig. 24). Occasionally a few rather large septa may be seen extending across the porencephaly (Fig. 2D).

There is a small group of lobe porencephaly in which the cyst is small, very ir-

mendous, smooth and regular in outline, and largely limited by the calvarium. The entire hemisphere is replaced by the cyst (Fig. 2 and 11). Complete drainage of the cerebrospinal fluid is rarely obtained and it may be difficult to demonstrate the lateral ventricle. As may be suspected this condition is occasionally difficult to differentiate from unilateral hydrocephalus.

Only 1 case of "closed" porencephaly occurred in this series. In this type the cyst is separated from the ventricle by a thin

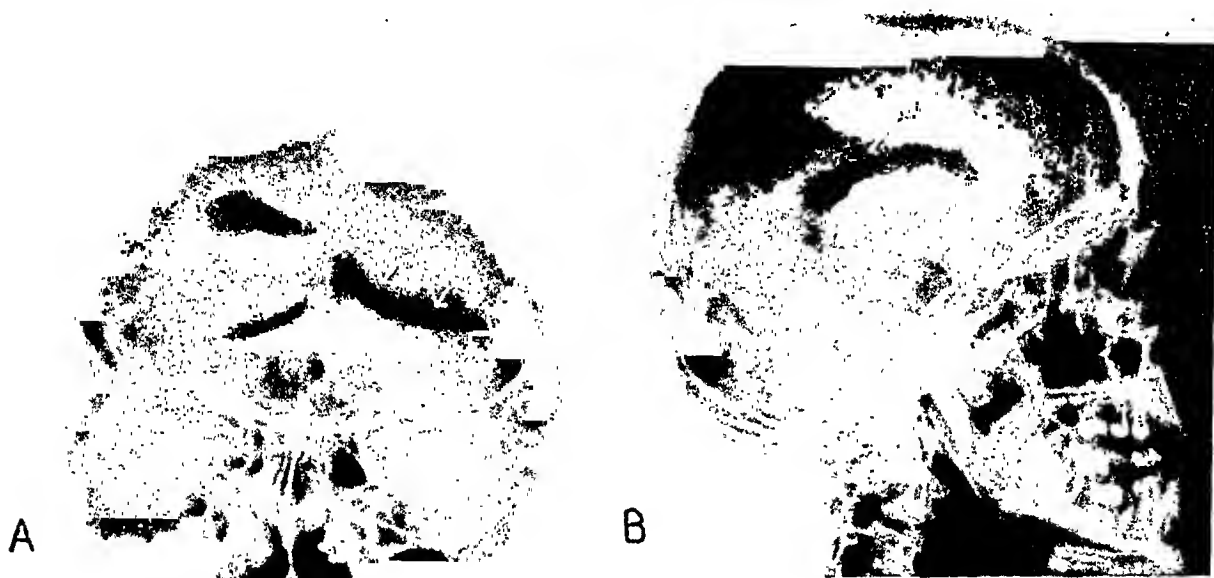


FIG. 14, *A* and *B*. (*A*) encephalogram of a twenty-four year old male with a left parietal lobe porencephaly. The falx and tentorium are displaced toward the air-filled cyst. The tentorium is outlined by the subdural air beneath it (arrows). (*B*) the communication of the porencephaly with the ventricle was demonstrated only in the lateral view and can be seen at *a*.

regular in outline, and may contain septa and diverticula or pseudopodia-like extensions (Fig. 6 and 15). Trauma is usually the suspected etiologic agent in this group. One of our patients (Fig. 16) had an unusual bone lesion, overlying the brain lesion, which was believed to be traumatic in origin. More rarely one may encounter lobe porencephaly in hydrocephalus. The porencephaly is small, unilateral or bilateral, and has an unusually narrow communication with the lateral ventricle (Fig. 4).

Hemisphere porencephaly is rather unusual and had an incidence of only 7 per cent in this series. Here the cavity is tre-

membrane and does not communicate with the subarachnoid space (Fig. 23). This type of lesion may, according to Penfield and Erickson,¹⁷ be caused by cerebral thrombosis or embolism. They believe the cyst remains closed because the ependymal wall of the ventricle is more resistant to anoxemia than the adjacent cerebral tissue.

Since porencephaly is an atrophic process, one would expect other manifestations of cerebral atrophy. Two-thirds of the group had other evidence of cortical or subcortical atrophy such as enlarged lateral ventricles or increase in the size of the subarachnoid pathways. The enlargement of the lateral ventricle may be localized or

general and is usually unilateral and homolateral. Not infrequently, there is bilateral enlargement and rarely there is greater enlargement of the lateral ventricle on the opposite side (Fig. 17). Arachnoiditis may

a diagnosis of arachnoiditis (Fig. 6). The literature^{4,17} gives one the impression that arachnoiditis is found only on the side of the porencephaly. We found diffuse bilateral arachnoiditis, or at least an absence

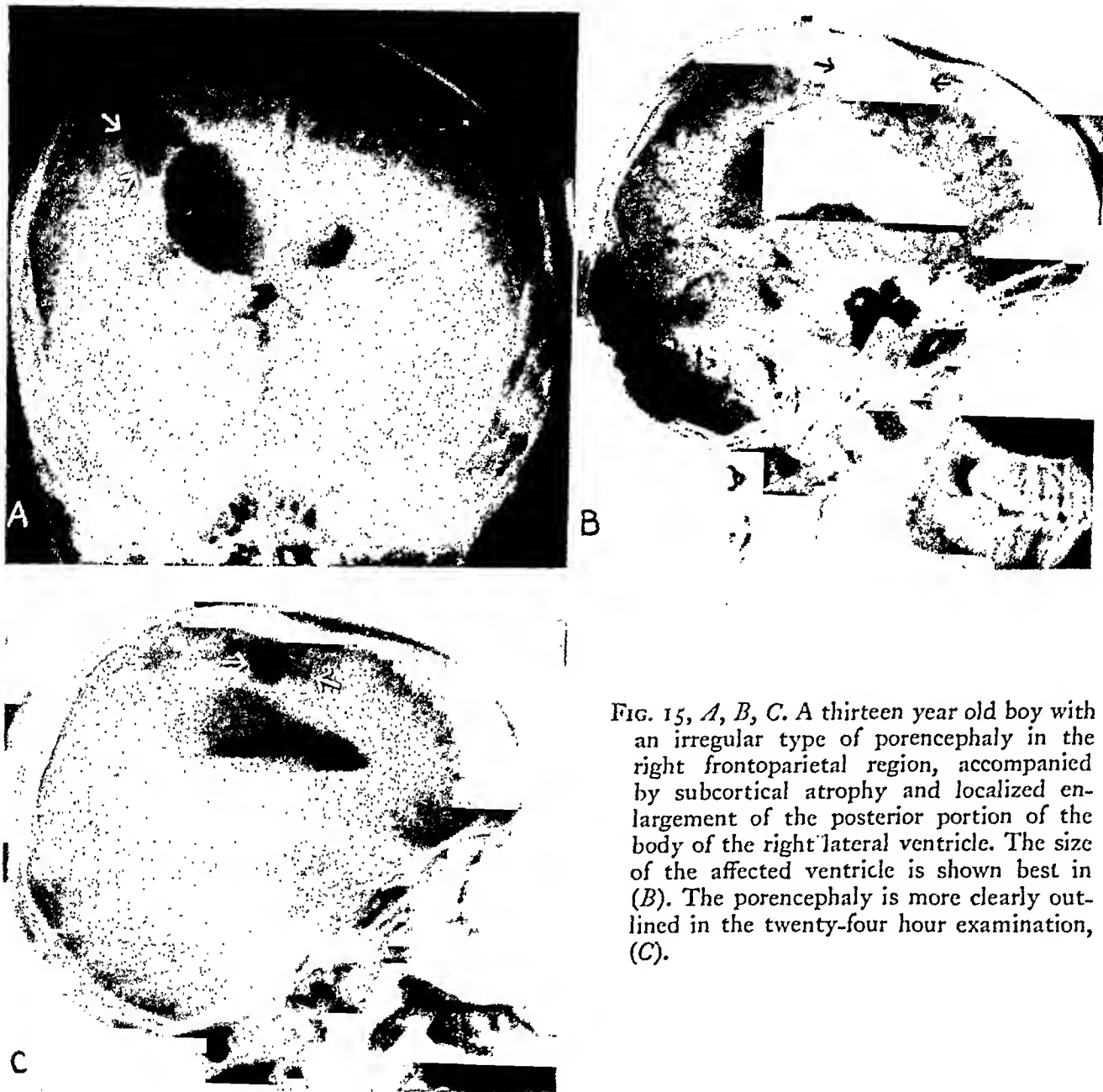


FIG. 15, A, B, C. A thirteen year old boy with an irregular type of porencephaly in the right frontoparietal region, accompanied by subcortical atrophy and localized enlargement of the posterior portion of the body of the right lateral ventricle. The size of the affected ventricle is shown best in (B). The porencephaly is more clearly outlined in the twenty-four hour examination, (C).

be an accessory factor in the production of hydrocephalus in some of the cases. A localized arachnoiditis is usually found overlying the cyst, and occasionally there is a generalized loss of subarachnoid pathways and obscuring of the basal cisternae. If one can be sure that complete or adequate drainage of the cerebrospinal fluid has been secured, one is justified in making

of subarachnoid pathways, to be more common that unilateral arachnoiditis. Not infrequently there is evidence of arachnoiditis only over the opposite hemisphere. A slight shift of the ventricles is usually present (88 per cent) and more often the shift is toward the porencephalic side because of the accompanying atrophy. There may be little shift even in the presence of large cysts

(Fig. 19). Contrary to the usual conception, there was displacement toward the opposite side in 10 instances. An adequate explanation is not always possible, but such a condition may be produced by the pressure of the cyst or greater atrophy of the

only if a portion of the injected air is subdural and beneath the tentorium (Fig. 14). Other associated findings may include cerebellar atrophy (Fig. 10) and abnormalities of the septum pellucidum. Perforation of the septum pellucidum was found twice

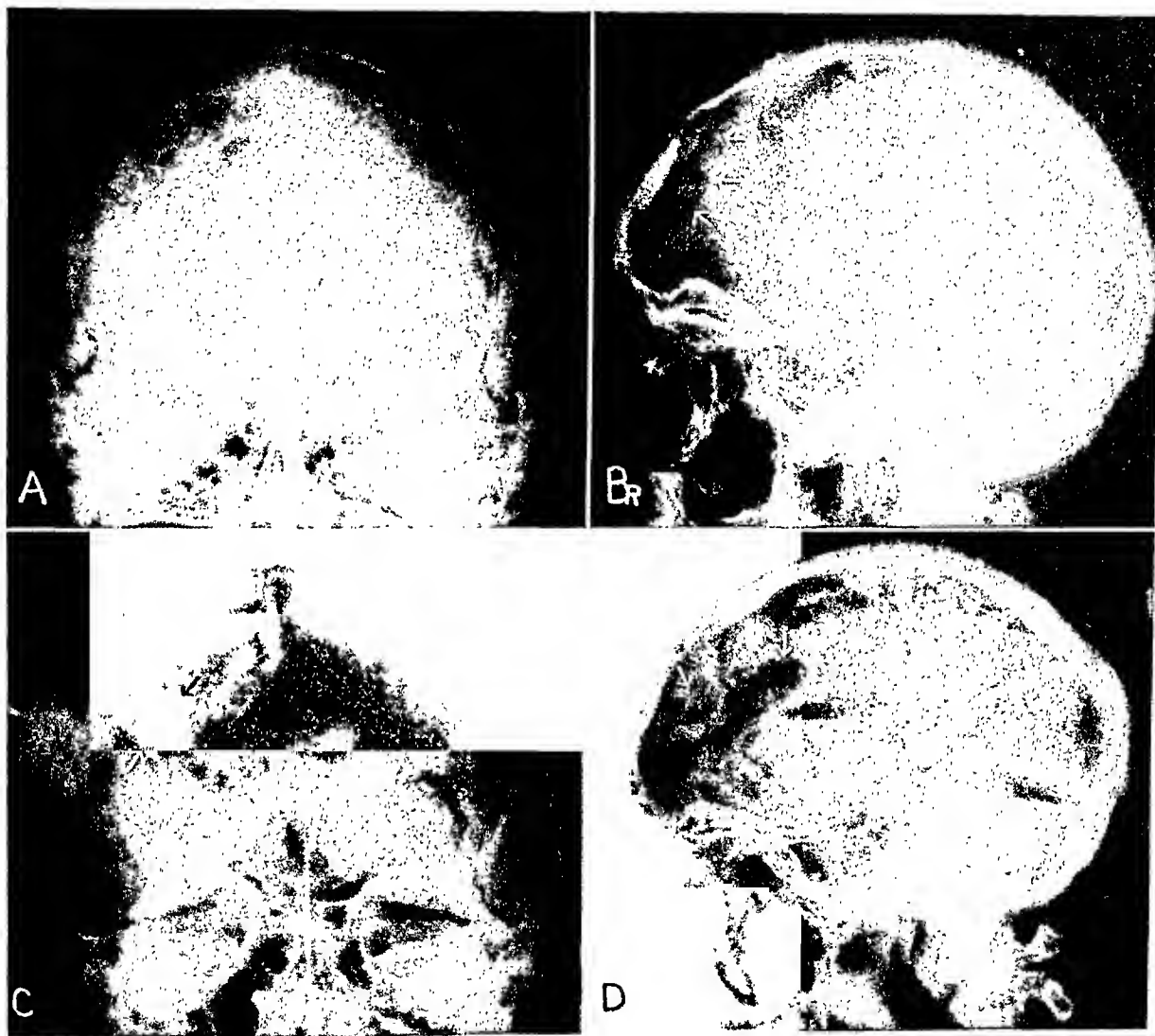


FIG. 16, A, B, C, D. An irregular right frontal lobe porencephaly in a twenty year old man. In (A) and (B) an unusual osteolytic process can be seen in the right frontal region. In (C) and (D) the porencephaly is in the frontal region. There is some midline shift of the falx toward the affected side.

opposite hemisphere (Fig. 3 and 18). In 1 patient there was bulging of the skull and displacement of the falx to the opposite side by the porencephaly and possible displacement of the third ventricle to the homolateral side (Fig. 18). The atrophy may be of such an extent that the tentorium is displaced upward. This is seen

and cavum septi pellucidi twice (Fig. 10). LeCount and Semerak¹¹ found the corpus callosum to be absent in 1 of their cases.

In many cases the diagnosis of porencephaly is not as simple as one would suspect. Either porencephaly or focal atrophy or both may follow localized contusion or laceration of the brain. According to Foer-

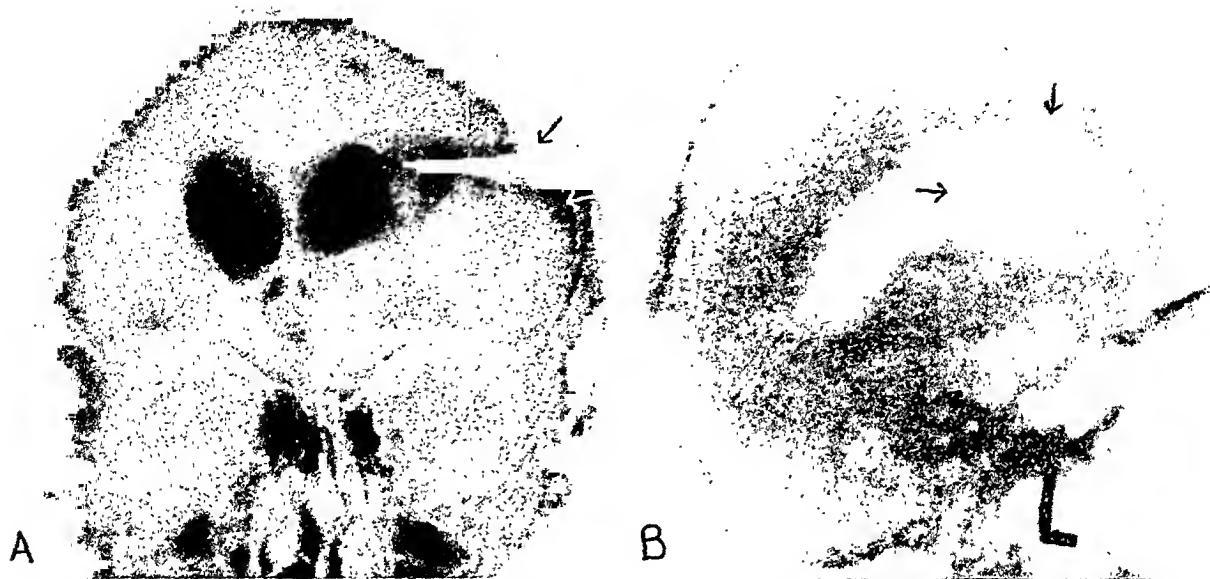


FIG. 17, *A* and *B*. Left frontal lobe porencephaly in a thirty-four year old male with no history of trauma. The right lateral ventricle is slightly larger than the left, seen best in (*A*).

ster and Penfield⁷ the patient may not develop symptoms for as long as fourteen years after the injury. With the development of focal atrophy the adjacent ventricular wall tends to migrate out toward the area. If a cyst has formed there is less migration.¹⁷ When the ventricular "diverticulum" has migrated to the meninges and has enlarged, it becomes exceedingly difficult to draw a line of differentiation be-

tween this and porencephaly (Fig. 17 and 22). As in 1 of our cases (Fig. 17), the absence of a history of trauma may be of some aid in this differentiation. Porencephaly may be difficult to differentiate from non-traumatic subcortical atrophy with dilatation of a portion of the lateral ventricle (Fig. 20). The variable posterior horn of a large ventricle must not be confused with porencephaly (Fig. 21). It may also be ac-

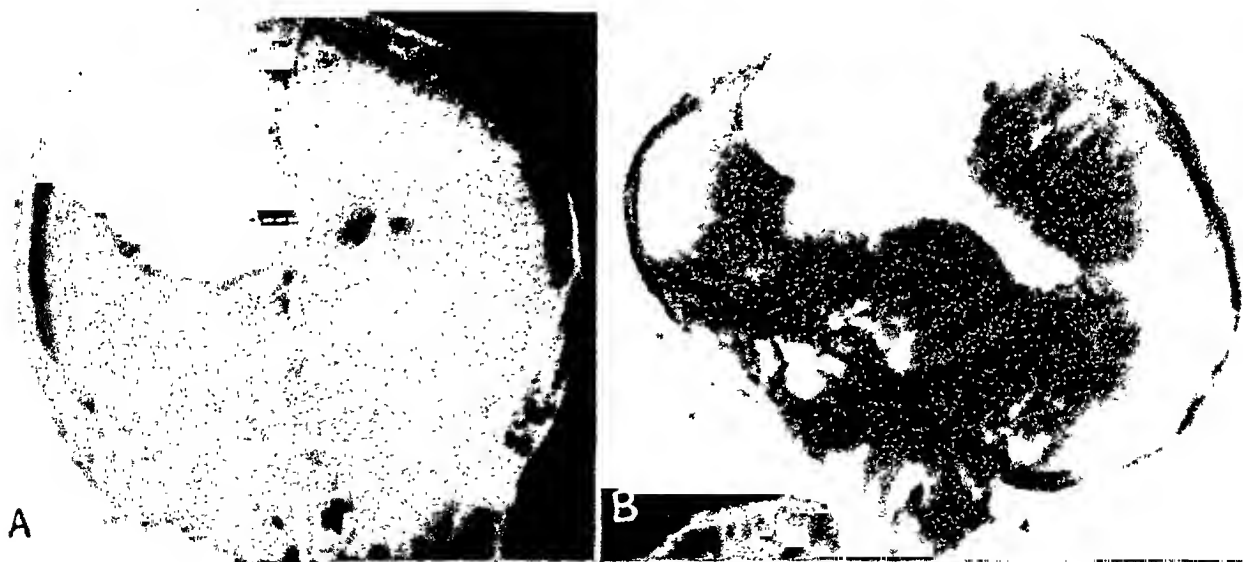


FIG. 18, *A* and *B*. A girl, aged fourteen, with a right frontal porencephaly. In (*A*) the vault on the right side is higher than the left, the falx is displaced to the left at *a* superiorly. The third ventricle, *b*, is in the midline or tilts slightly to the right. In (*B*) the large circular porencephaly is seen to good advantage.

accompanied by a marked localized cortical atrophy with patchy arachnoiditis (Fig. 15), and the enlarged cortical pathways themselves may in some areas simulate porencephaly. Reavis and Kilby¹⁹ believe an air-filled subdural hematoma cyst may be confused with porencephaly. This has not occurred in our experience.

The differentiation of hemisphere porencephaly (Fig. 2, 11 and 12) from extensive unilateral hydrocephalus in which the ventricle has been incompletely drained may be most difficult. Conventional roentgenograms in the hydrocephalic child are more likely to show enlargement or bulging of the skull. Sufficient drainage of the cerebrospinal fluid must be obtained to demonstrate the characteristic ventricular contour in unilateral hydrocephalus (Fig. 12). In most instances filling of the ventricle as well as the porencephaly is discernible in the posteroanterior and anteroposterior projections. The twenty-four hour examination may reveal a previously unfilled ventricle. If the ventricle is not demonstrable the porencephaly may be sufficiently filled to reveal its extent and rule out the possibility of its being only an enlarged ventricle.

Malignant gliomas are the most important lesions to be differentiated from porencephaly. Calcification in the wall of the cyst may simulate that seen in malignant gliomas or tuberculomas (Fig. 7 and 8). Occasionally the gliosis in the wall of the porencephaly may be confused microscopically with tumor tissue.

CASE REPORTS

CASE I. A nineteen year old boy was admitted on July 24, 1934, complaining of convulsions for seven years. He had had a right hemiparesis since infancy. In 1927 an exploratory craniotomy was performed revealing a very extensive subarachnoid cystic accumulation just behind the left Rolandic fissure. Strips of celloidin tissue were placed beneath the arachnoid to provide drainage of the subarachnoid space. He was subsequently followed in the clinic, showing little improvement. On readmission in 1932, an encephalogram was done, revealing cortical



FIG. 19. Encephalogram of a twenty-two year old woman with a large left interlobe parieto-occipital porencephaly showing little if any displacement of the midline structures.

atrophy or scar formation in the left parietal region. The left lateral ventricle was larger and extended laterally further than the right (Fig. 22). Following this his convulsions continued, becoming slightly more severe prior to readmission. Another encephalogram following readmission on July 10, 1934, revealed enlargement of the localized area of dilatation of the left lateral ventricle. On August 10, 1934, the craniotomy site was again exposed. The dura was thickened and there were many adhesions, some vascular, between the dura and cortex. Scar tissue ran down along the Sylvian fissure and the ventricle came to the surface in the middle of the supramarginal gyrus. The scar along the Sylvian fissure and the thickened wall of the porencephaly were dissected free, excessive vascularity being noted. Three days postoperatively he became stuporous and died.

Microscopic Report of Specimen: "The tumor is very cellular and very fibrillar. The cells run

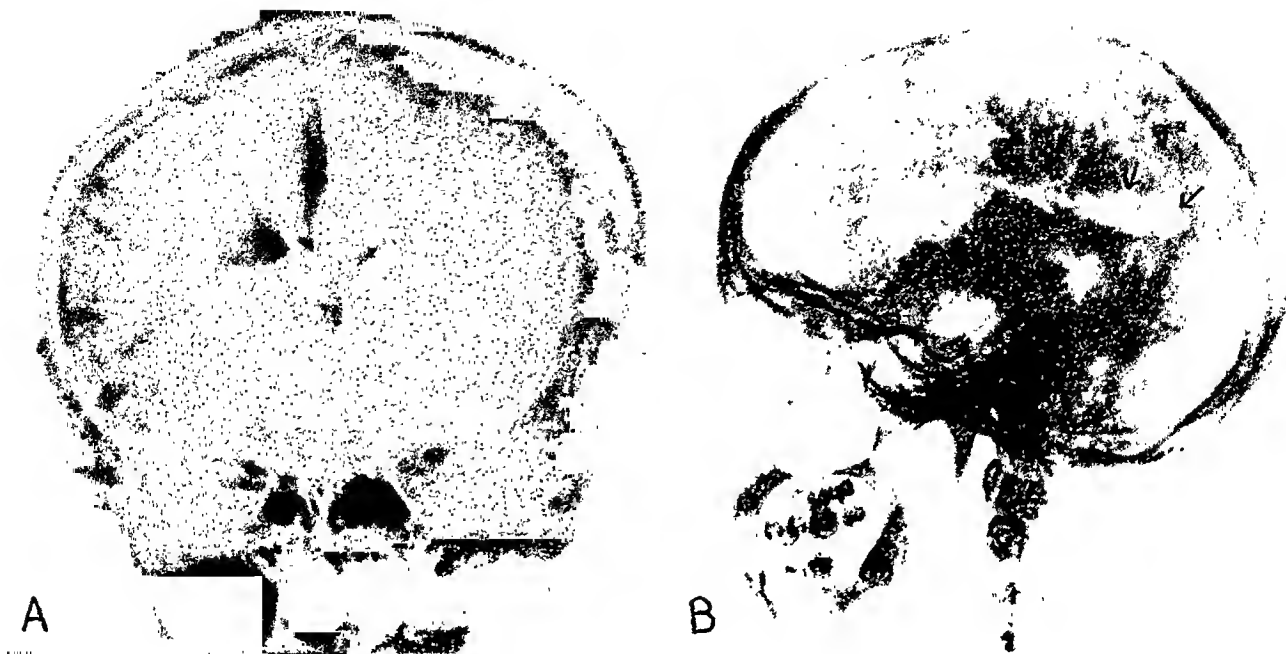


FIG. 20, *A* and *B*. A sixteen year old girl with an air-filled cavity in the right parieto-occipital region. The appearance could be that of a subcortical atrophy with localized dilatation of the posterior portion of the lateral ventricle, or it could be a porencephaly which has been incompletely visualized.

in many different directions in streams which penetrate here and there. There are many vessels. Fibrous stroma is scanty. There are large numbers of long, wavy, hard fibrils which run in parallel bands and which are particularly dense around the blood vessels. The cells have oval vesicular nuclei. There are no mitoses. Diagnosis: Astrocytoma."



FIG. 21. A partially filled posterior horn of the lateral ventricle which does not represent porencephaly. The posterior horn air shadow frequently does not communicate with the air shadow of the body of the ventricle. This we believe is due to incomplete drainage of the cerebrospinal fluid.

Comment. This case was clinically and roentgenologically undoubtedly a traumatic lobar porencephaly. The slide and history were recently presented to Dr. Bernard J. Alpers, Professor of Neurology, Jefferson Medical College. His report was as follows: "If I did not have the history and were asked to make a diagnosis on the basis of the specimen alone, I should be forced to call it an astrocytoma. In view of the history, however, I am forced to regard it as a severe degree of gliosis. It serves as an example of the difficulty that may exist in making a clear cut distinction between gliosis and tumor, and in this instance the glial overgrowth is so great that it has the typical appearance of an astrocytoma."

Strom-Olsen²⁰ and Jaffé⁹ and others have described exaggerated gliosis and membranes of fibrillar glia separating the cysts from the white matter. The wall of the cyst itself may consist of an outer connective tissue layer and an inner layer of fibrillary glia which in places swell up into cellular plaques, containing many dark brown and yellowish brown pigment granules (Jaffé).⁹ It is readily understandable that in instances such as this the microscopic appearance may be most confusing and must

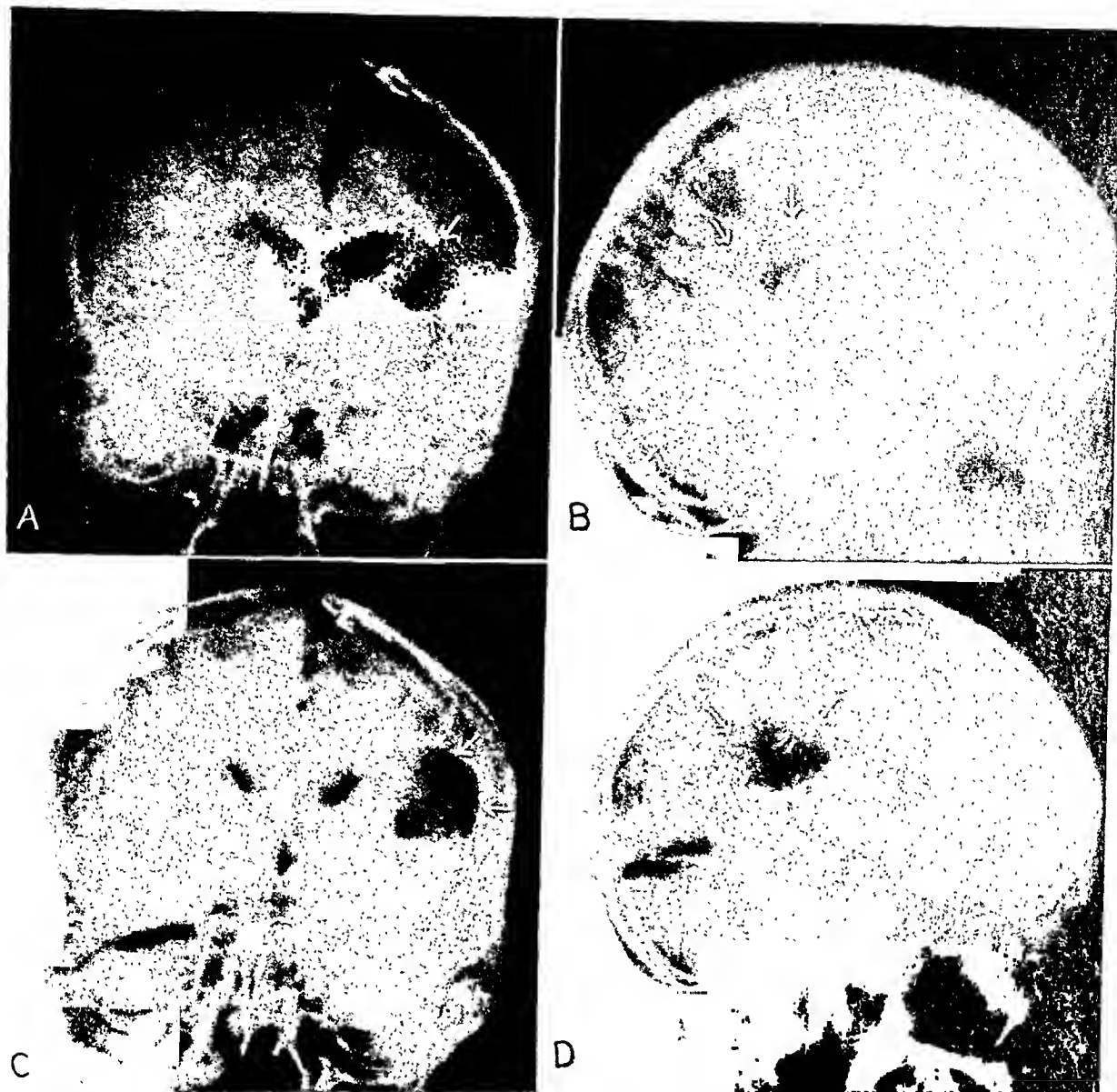


FIG. 22, *A, B, C, D.* Case 1. Encephalogram of a seventeen year old boy with a postoperative ventricular diverticulum in the left parieto-occipital region, (*A*) and (*B*). The walls of the process continued to migrate to the periphery until it became a porencephaly two years later, (*C*) and (*D*).

be interpreted in the light of the clinical findings. This case (Fig. 22) also serves to illustrate the development of a porencephaly following possible birth injury and the trauma of a craniotomy. The appearance is not unlike "the migrating ventricle" following penetrating wounds.¹⁷

CASE II. A twenty-eight year old white female was admitted to the Neurosurgical Service complaining of weakness in the left leg for one and one-half years. Weakness of the left arm began eight months before admission. Right facial numbness and weakness had been present for three months. Physical examination revealed a

hyperesthesia of the right face and scalp, left hemiparesis with hyperactive reflexes, left Babinski sign, and bilateral papilledema OD=5 diopters, OS=4 diopters. Plain roentgenograms of the skull revealed a slight increase in the prominence of the digital markings and erosion of the dorsum sella. A preoperative ventriculogram revealed a mass lesion in the right frontoparietal region, causing marked ventricular distortion and displacement of the midline structures and ventricle to the left (Fig. 23).

On the second day of admission a right frontotemporal parietal craniotomy was performed. The dura showed no abnormalities, but yellowish discoloration involved the upper post

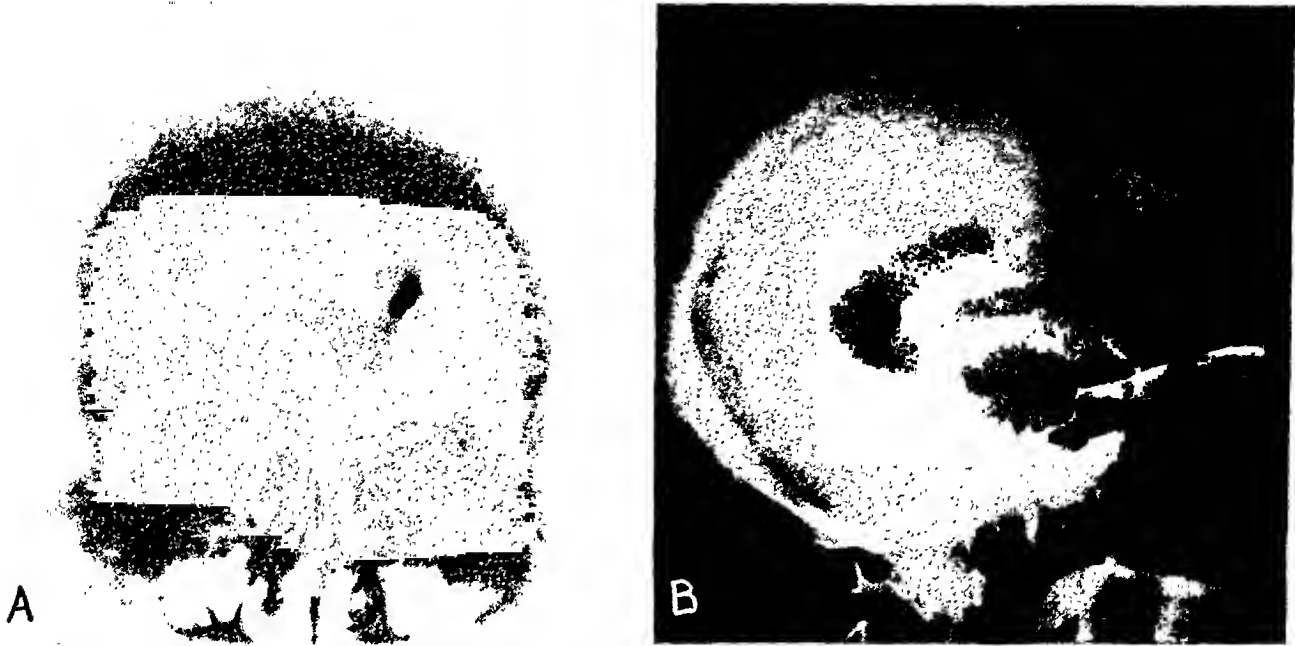


FIG. 23, *A* and *B*. Case II. A right frontoparietal "closed" porencephaly in a woman aged twenty-nine, causing marked ventricular shift and distortion. The appearance cannot be differentiated from that of other mass lesions. Note the thinning of the dorsum sellae.

central gyrus and motor cortex. Clear fluid was aspirated from this region. A transcortical incision exposed a large cyst about 3 inches in diameter, bordered by the falx medially. The wall was soft and slightly yellowish. At no point was there a nubbin of tumor. A communication with the ventricle could not be demonstrated. It seemed that the lesion in all probability was a porencephalic cyst. Five small pieces of tissue

were removed from the wall of the cyst.
Microscopic Report of Specimen: "The tissue represents the covering layer of a cortical cyst. It contains a number of nerve cells, irregularly distributed, and fairly large glia nuclei without glia fibre formation. Diagnosis: Porencephalic cyst."

Comment. Various authors^{4,13,19} have

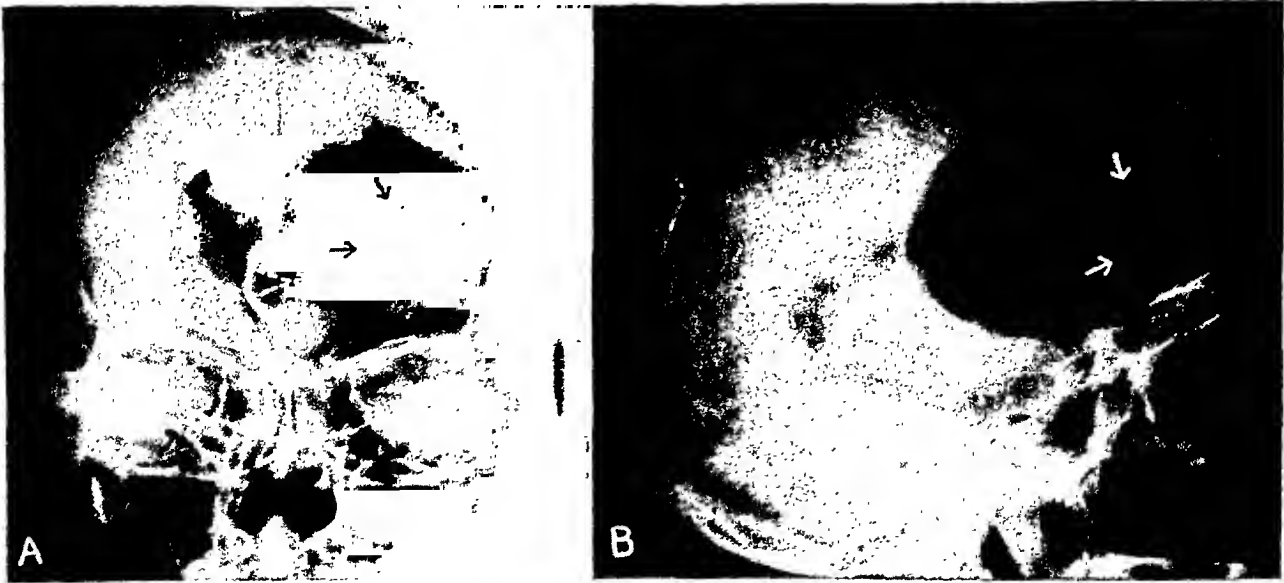


FIG. 24, *A* and *B*. Case III. Porencephaly in the left frontal region of a thirty-one year old male. In (*A*) there is a soft tissue shadow occupying the anterolateral aspect of the air filled porencephaly that looks very much like a nubbin of a glioma (see Fig. 27). The falx is displaced to the right at *a*. In (*B*), the daughter cyst can be seen in the lateral view.

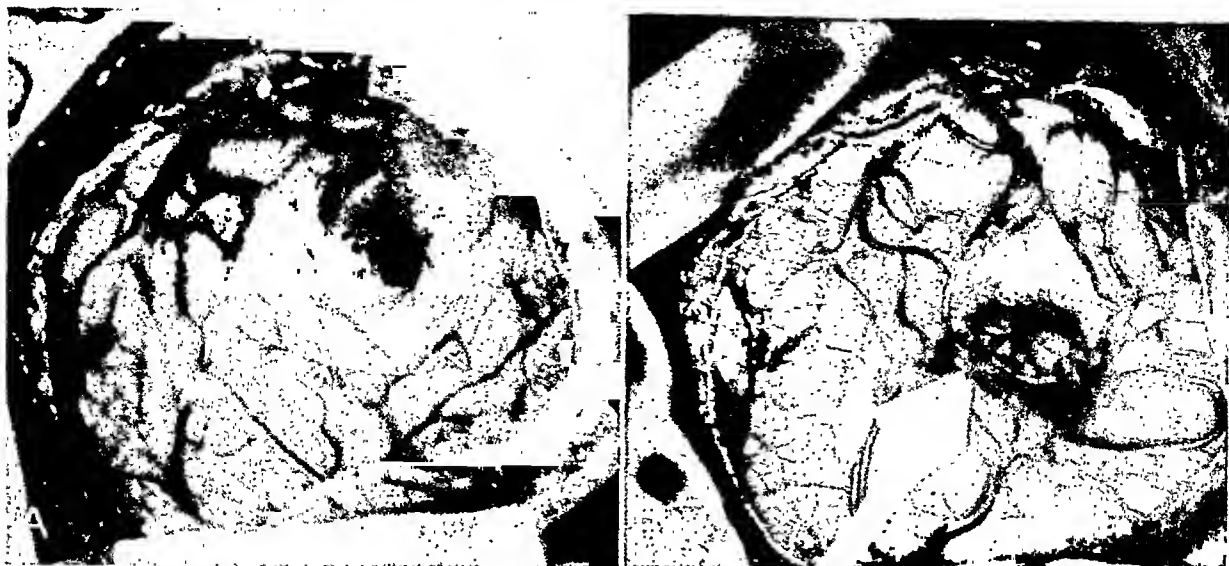


FIG. 25, *A* and *B*. Same case as Figure 24. In (*A*), one can see the appearance before operation on the cyst. In (*B*) the roof of the cyst has been removed showing the extent of the lesion.

stated that porencephaly may be differentiated from gliomatous cysts by the lack of atrophy, encroachment on, rather than dilatation of the ventricle, and the displacement of the ventricles to the opposite side. Reavis and Kilby¹⁹ further state that gliomatous cysts generally do not communicate with the ventricle. It is readily apparent that this case of closed porencephaly embodies all the characteristics of a mass lesion and cannot clinically or roent-

genologically be differentiated from other mass lesions such as a brain tumor.

CASE III. A thirty-one year old white male was admitted complaining of frontal headaches of increasing severity for six months. He had vomited on five occasions without nausea. Forgetfulness and trance-like states subsequently were noted, and for three weeks there had been blurring of vision in the left eye. Examination revealed a decrease in the sense of smell on the left, bilateral papilledema, 4 diopters, slight

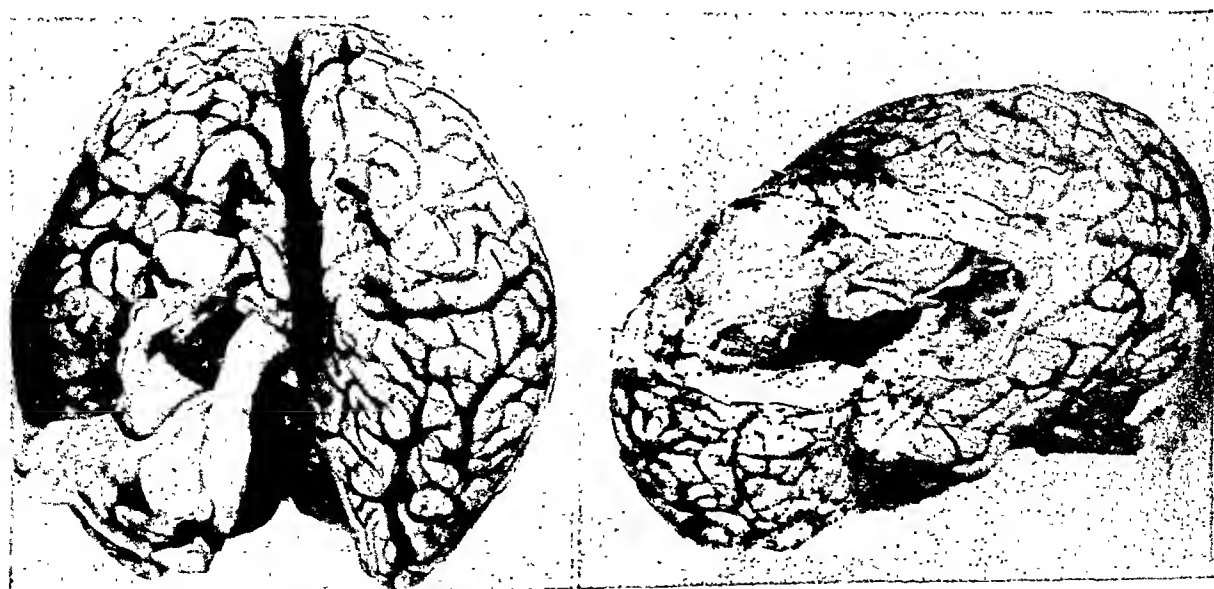


FIG. 26, *A* and *B*. Brain specimens of porencephaly. (*A*) porencephaly of left occipitoparietal region. (*B*) porencephaly in the left frontoparietal region.

weakness of the right extremities, with hyperactivity of the reflexes greater on the right. Plain roentgenograms of the skull revealed a calcified pineal body displaced to the right, downward, and backward. A preoperative ventriculogram revealed what was believed to be a large cystic glioma in the left frontal region. In the anterolateral portion of the air-filled cyst, a soft tissue mass with a rather smooth border was noted. The lateral and third ventricles were displaced to the right (Fig. 24 and 25).

A left frontoparietal craniotomy revealed the frontal dura to be discolored and hemorrhagic in appearance. Upon exposure of the cortex, a cyst was revealed in the anterior half of the frontal lobe. Several small cysts filled with fluid were noted in the large air-filled cyst which communicated with the ventricle. The cap of the cyst and the smaller cysts were removed and the communication with the ventricle was enlarged. Part of the cyst wall was removed for pathological study. No tumor tissue was seen at any point along the entire wall of the cyst.

Pathological Report of Specimen. "The specimen consists of four pieces of brain tissue covered with arachnoid on the surface and a smooth, slightly brownish layer through which fine blood vessels run on the inside. The thickness of the brain substance is 2 to 4 mm. The impression is that this is a cyst formation containing about 3 cc. of slightly bloody fluid. The brown surface of the cyst wall suggests the deposit of blood pigment."

Microscopic Description. "This is a piece of white matter covered with spindylia. The subspindylial layer is unusually thick. Hemosiderin is deposited here. The tissue towards the cortex contains nerve cells; however, without any definite architecture. Diagnosis: Porencephalic cyst."

Comment. Love and Groff¹² have reported a case of porencephaly with papilledema markedly improved by operation. It is generally believed, however, that the increased intracranial pressure with papilledema and erosion of the dorsum sellae noted in Cases II and III is not encountered in porencephaly. This case illustrates the difficulty one may experience in differentiating a communicating lobar porencephaly with mural cysts (Fig. 24) from a cystic glioma with a mural nubbin (Fig. 27).



FIG. 27. Cystic glioma in the right parieto-occipital region of a sixteen year old girl. The nubbin of the glioma in this instance is similar in appearance to that produced by a daughter cyst in the porencephaly (Fig. 24, B).

SUMMARY

We have reviewed a series of 29 cases of porencephaly. The etiologic factors, the symptomatology, and the location of the various lesions have been briefly discussed.

Unilateral change in the thickness of the skull was the most common observation in the conventional roentgenograms of patients with porencephaly. Generalized or localized thinning was most frequently present, and unilateral thickening of the vault was less often demonstrable. Asymmetry of the vault was also occasionally observed. Calcification similar to that in malignant gliomas was found in one instance.

Encephalography or ventriculography is necessary to establish the diagnosis of porencephaly.

The various types of porencephaly have been described and classified as "lobe," "interlobe," and "hemisphere."

Cortical or subcortical atrophy, enlargement of the ventricles, and arachnoiditis were found in association with porencephaly and may be contralateral, homolateral, or bilateral, and localized or generalized. There was usually a slight shift

of the ventricles and midline structures more often to the same side but frequently to the opposite and occasionally quite marked.

Porencephaly must always be considered in the differential diagnosis of mass, cystic and contracting lesions involving the brain. Cases were presented which clinically and roentgenologically could not be distinguished from mass lesions.

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REFERENCES

1. BERNSTEIN, E. L. Psychiatric aspects of porencephaly. *Am. J. Psychiat.*, 1939, 96, 725-731.
2. BERRY, R. J. A., and BATES, R. M. Case of porencephalic imbecility. *Brit. M. J.*, 1932, 1, 830-832.
3. DAVIDOFF, L. M., and DYKE, C. G. Relapsing juvenile subdural hematoma. *Bull. Neurol. Inst. New York*, 1938, 7, 95-111.
4. DE SANCTIS, A. G., GREEN, M., and LARKIN, V. DE P. Porencephaly. *J. Pediat.*, 1943, 22, 673-689.
5. EISENSTEIN, V. W., and TAYLOR, H. K. Porencephalic cyst; report of case with arteriographic studies. *Arch. Neurol. & Psychiat.*, 1941, 45, 1009-1014.
6. EVANS, J. P., and McEACHERN, D. Circulatory changes in cerebral vascular occlusion and in cerebral cicatrization. *A. Research Nerv. & Ment. Dis.*, Proc. (1937), 1938, 18, 379-393.
7. FOERSTER, O., and PENFIELD, W. Structural basis of traumatic epilepsy and results of radical operation. *Brain*, 1930, 53, 99-119.
8. GLOBUS, J. H. Contribution to the histopathology of porencephalus. *Arch. Neurol. & Psychiat.*, 1921, 6, 652-668.
9. JAFFÉ, R. H. Traumatic porencephaly. *Arch. Path.*, 1929, 8, 787-799.
10. LAIRD, A. Study of porencephaly. *J. Nerv. & Ment. Dis.*, 1938, 87, 317-321.
11. LECOUNT, E. R., and SEMERAK, C. B. Porencephaly. *Arch. Neurol. & Psychiat.*, 1925, 14, 365-383.
12. LOVE, J. G., and GROFF, J. E. Porencephalic cyst; report of case. *Proc. Staff Meet., Mayo Clin.*, 1939, 14, 709-712.
13. PATTEN, C. A., GRANT, F. C., and YASKIN, J. C. Porencephaly; diagnosis and treatment. *Arch. Neurol. & Psychiat.*, 1937, 37, 108-136.
14. PENDERGRASS, E. P., and HODES, P. J. Encephalography; value of second-day examination. *Radiology*, 1936, 26, 146-150.
15. PENFIELD, W. Mechanism of cicatricial contraction in the brain. *Brain*, 1927, 50, 499-517.
16. PENFIELD, W. Epilepsy and surgical therapy. *Arch. Neurol. & Psychiat.*, 1936, 36, 449-484.
17. PENFIELD, W., and ERICKSON, T. C. Epilepsy and cerebral localization. Charles C Thomas, Springfield, Ill., 1941.
18. PHEMISTER, D. B. Brain cyst following skull fracture. *Surg. Clin., Chicago*, 1917, 1, 971-977.
19. REAVIS, C. W., and KILBY, W. L. Porencephaly. *Bull. School Med. Univ. Maryland*, 1942, 26, 190-197.
20. STROM-OLSEN, R. Porencephaly; brief review with description of case. *Lancet*, 1931, 1, 1185-1186.
21. WILSON, S. A. Neurology. Williams and Wilkins Co., Baltimore, 1940.
22. WINTERODE, R. P., and LEWIS, N. D. C. Case of porencephalic defect associated with tuberculous encephalitis. *Arch. Neurol. & Psychiat.*, 1923, 10, 304-313.



PNEUMATOSIS INTESTINALIS

ITS ROENTGENOLOGIC DIAGNOSIS*

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PNEUMATOSIS is defined as the presence of gas in an abnormal location in the body. When gas gathers into cyst-like accumulations within the wall of the intestine, the condition is known as "pneumatosis cystoides intestinalis." The diffuse spread of the gas into the intestinal tissues is labeled as "intestinal emphysema." These entities have been reported in the literature under such descriptive titles as "gas cysts of the intestine," "emphysema intestinorum," "diffuse emphysema of the intestinal wall," "multiple cysts of the intestine," and "emphysema of the cecum."

HISTORY

In 1876, Bang¹ published the initial description of pneumatosis intestinalis. In the most recent review of the subject, Jackson,² in 1940, accumulated all the purported cases available in the literature and added a case of his own, bringing the total to 172. Of these, 12 occurred in children and 160 in adults. The subject has been rarely reported in the American literature.

ETIOLOGY

Three major hypotheses have been propounded to explain the mechanism of the production of pneumatosis intestinalis.

(1) *Neoplastic*. This theory assumes the existence of a specific type of cell capable of secreting gas. The lack of satisfactory histopathological substantiation obviates acceptance of this presumption.

(2) *Bacterial*. This postulate presumes that bacterial action produces the gas in the interstitial tissues of the bowel wall. The majority of bacteriological studies in the reported cases failed to reveal the

presence of bacteria. The clinical picture of the cases reported was unlike that which would be expected with a gas-forming infection. Furthermore, chemical analysis of the gas collected from the cyst-like areas has demonstrated the presence of oxygen, a finding which is not associated with bacterial lesions.

(3) *Mechanical*. This hypothesis presupposes a break in the integrity of the mucosa due either to over-distention of the intestine by gas or localized infection of the mucous membrane. With an increase in intraluminal pressure (i.e. hyperperistalsis or obstruction) gas is forced through the mucosal defect into the intestinal wall and tends to accumulate beneath the serosa. When the dissecting gas reaches the retroperitoneal region, it may spread rapidly over extensive areas, the extent and direction of spread being governed by the peritoneal planes and attachments. It should be emphasized that the gas is never intraperitoneal or "free" unless a break in the peritoneum itself occurs.

This hypothesis has the strongest evidence in its support. The majority of the reported cases are found in association with ulcerative diseases of the gastrointestinal tract, which present concomitant elements of obstruction and hyperperistalsis. Nitch and Shattock,³ in analyzing 85 cases, reported that approximately 55 per cent occurred in patients with peptic ulcer and that 83 per cent were associated with varying degrees of intestinal obstruction.

CLINICAL FINDINGS

The clinical findings in cases of pneumatosis intestinalis vary with the extent

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and location of the gas. By itself this entity may be asymptomatic. However, as the gas accumulates, it may produce invagination of the mucosal and muscular coats of the bowel wall. With progressive accumulation of the gas, sufficient reduction of the lumen may occur to produce partial or even complete obstruction.

The major portion of the symptomatology is due to the complications attending pneumatosis. The primary pathology such as ulcer with stenosis or rupture, gastritis, etc., often overshadows the symptoms due to the pneumatosis so that it is not recognized. Physical examination may reveal a distended loop of bowel which simulates a tumor. The "tumor" is tender, has a spongy feel and is freely movable. It varies in size and consistency from day to day. Crepitation may be noted.

The variegated findings have led to such diagnoses as appendicitis, appendiceal abscess, malignancy and acute or chronic obstruction.

PATHOLOGY

The gross pathology is dependent upon the site and degree of the gaseous infiltration. The majority of cases have been localized to the ileocecal region. When associated with pyloric stenosis, the jejunum, omentum, and gastrohepatic ligament have been involved. The extent of the pathology varies from minimal accumulations of gas which are localized into discrete cyst-like formations to the extreme stage manifested by a sausage-like enlargement of the intestine due to diffuse emphysema. The cysts may grossly resemble hydatid cysts, but upon puncture, gas rather than fluid escapes. Characteristically, pressure upon the individual loculations of gas causes them to change their shape and position.

Microscopically, the blebs have no content other than gas except for occasional instances where they have been reported as containing small amounts of serum-like material. The cysts may show no obvious epithelial or endothelial lining but at times give the impression of being lined with serosa-like cells. They may resemble lymph

spaces and this finding has been the basis for the theory that the gas is disseminated from the bowel lumen along the lymphatic channels. Varying degrees of inflammatory changes in the vicinity of the gas may be found. Hemorrhage, edema, granulocyte infiltration and giant cells have been reported but no characteristic pathological picture has been established. A distinction has been drawn as to the location of the gas spaces in children as compared to adults. In children, the gas is found predominantly in the mucosa and submucosa while in adults the gas accumulates in the subserosal plane.

ROENTGENOLOGIC DIAGNOSIS

Although the roentgenologic features of pneumatosis intestinalis has been noted in the European literature, no complete description has been given in the American reports. Lindsay, Rice and Selinger⁴ stated, "Postmortem examination and operative intervention have been necessary for the recognition of this lesion; the diagnosis has never been made prior to one or the other of these two procedures." Pneumatosis intestinalis is undoubtedly fairly common but is overlooked due to the focusing of the physician's attention upon the basic pathology.

The roentgen findings consist primarily of the presence of translucent areas (gas) lying within the contour of the normal bowel. When a contrast medium such as barium is used, there is an inability to completely fill out the lumen of the bowel, giving the impression of filling defects. These, however, are inconstant and have a decreased density rather than an increased density such as is seen with tumor. The areas of decreased density lie between the contrast medium and the outer limits of the intestinal wall. They represent the accumulations of gas beneath the serosa which, forcing the mucous membrane and muscularis inward, produce the filling defects. The presence of inconstant filling defects of increased translucency is pathognomonic.

When the gas escapes from the limitation imposed by the serosa, its configuration in

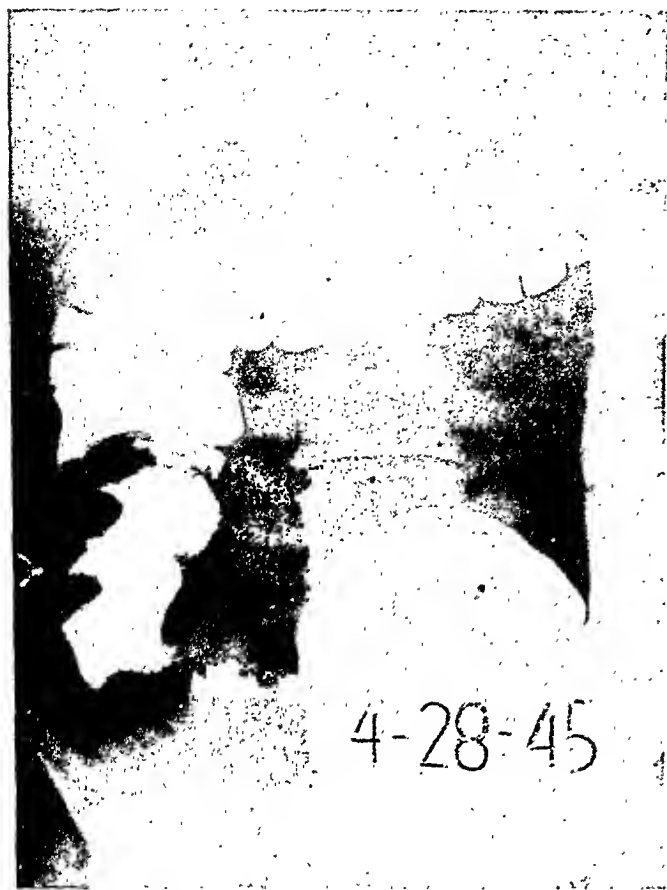


FIG. 1. Arrow points to translucent polypoid filling defects present in the cecum and ascending colon. These were originally thought to be due to tumor formation in the cecum. The remainder of the colon is entirely normal.

the retroperitoneal space is determined by the resistance of the tissues with which it comes in contact. The extent and rapidity with which it disseminates depends upon the maintenance of the increased intraluminal pressure, the persistence of the mucosal defect, and the rate of absorption. The gas may pass out between the layers of the mesentery, dissecting posteriorly and upward, coming to lie under the diaphragm and thus simulating free air in the abdomen. Lateral decubitus roentgenograms show that the air is not free. Extension into the mediastinum along the great vessels with the production of mediastinal emphysema is possible.

TREATMENT

The earlier literature is replete with case reports in which, because of the severity of the clinical findings, the patients were operated upon and the involved bowel often resected. In some instances, the blebs were

merely evacuated. Recently it has been suggested that pneumatosis of itself is a benign process and should be treated as such. Reports have shown that the blebs may be absorbed in as short a time as three months.

The essence of the present status is that surgical intervention is determined by the primary pathology rather than the pneumatosis. If obstruction is present and observation shows a failure of resolution, interference is warranted. The absence of septic complications with pneumatosis is unusual and is worthy of note.

CASE REPORT

The patient was an Italian, male, aged twenty-two. He was first admitted to the hospital on April 17, 1945. His chief complaint was pain in right lower quadrant of five days' duration. The pain had first occurred five days previous to entry, appearing at night while resting. There had been mild burning in the epigastrium upon arising in the morning. There were no bowel disturbances, nausea or vomiting. Past history was irrelevant except for an appendectomy three years prior to admission. On physical examination, the only positive finding was an old scar in the right lower quadrant.

Laboratory Findings. Red blood count, white blood count, sedimentation rate, urinalysis and repeated stool cultures were negative. Stool examination for occult blood was positive until the patient was put on a meat-free diet when it became negative.

Course. The patient was afebrile during his first admission. Medication consisted of tincture of belladonna and elixir of phenobarbital daily. Bile salts were administered on April 19, 20, 21 and 22. Diarrhea appeared on April 23 and was treated with paregoric and bismuth.

Roentgen Examination. Examination on April 28, 1945, following barium enema (Fig. 1) was reported as showing multiple, translucent, polypoid defects in the region of the cecum and proximal half of the ascending colon. A roentgenogram of the chest on April 29 was reported as normal.

Subsequent Course. On May 2 the patient began to vomit frequently and was unable to retain any food.

On the basis of these findings, the patient was transferred to this hospital with a diagnosis of

intestinal obstruction due to tumor in the cecal region.

Transfer Admission, May 5, 1945. At the time of the transfer admission, the patient complained of pain in the right lower quadrant associated with nausea and vomiting. The pain was continuous, localized to the right lower abdomen and was associated with irregular abdominal cramps and distention. At this time the patient stated that for the past two years he had had frequent episodes of abdominal pain which were not related to the intake of food and not relieved by the taking of soda.

Physical examination at this time revealed a palpable mass in the right lower quadrant which was freely movable and soft.

Complete laboratory studies were normal. Temperature, pulse and respiration were normal.

Roentgen Examination. A survey roentgenogram of the abdomen was made on May 7, 1945 (Fig. 2). There is an unusual distribution of gas throughout the entire colon clearly outlining the haustral markings. There is, in addition, an

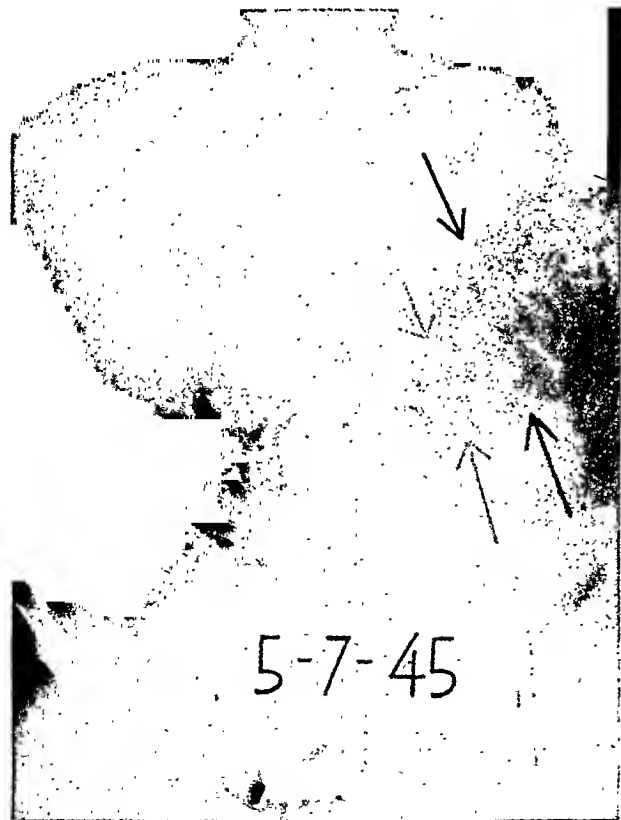


FIG. 2. Flat roentgenogram of the abdomen. Note double effect of gas pattern from cecum to splenic flexure. Medial set of arrows points to contour of colon with outlining of haustral markings by gas. The lateral set of arrows points to the gas around the bowel and in the retroperitoneal spaces.

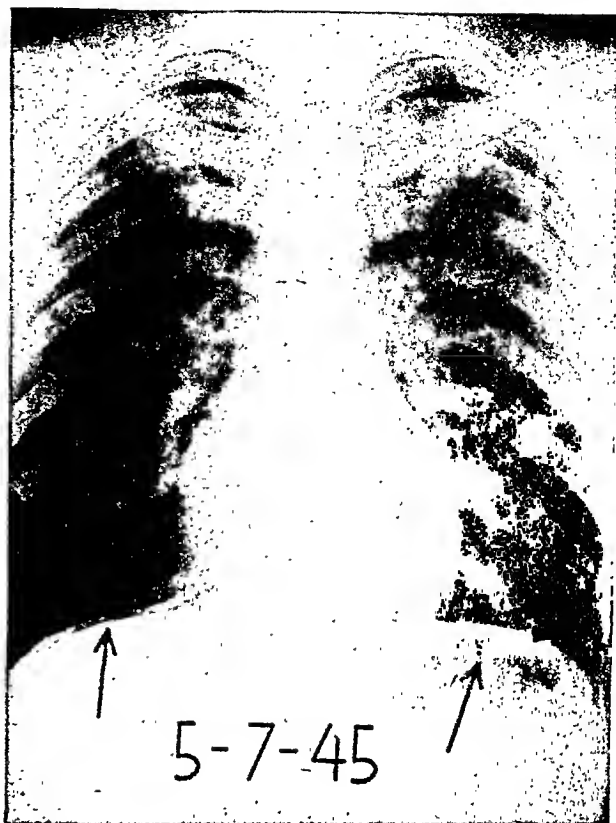


FIG. 3. The arrow beneath the right leaf of the diaphragm points to the gas present between the peritoneal and muscular layers of the right leaf of the diaphragm. The arrow above the left diaphragm points to the thin line of gas in the region of the left leaf of the diaphragm.

accumulation of gas outside of the bowel lumen, lying in and adjacent to the bowel wall. This gas is not free in the abdomen.

In light of the roentgenograms taken at this patient's first examination plus those at this examination, the diagnosis of pneumatosis cystoides intestinalis was made.

The roentgenogram of the chest (Fig. 3) revealed the following: There is a small accumulation of gas beneath the right leaf of the diaphragm. There is a thin line of decreased density beneath the left leaf of the diaphragm, which probably represents gas. These accumulations of gas apparently lie between the muscular and peritoneal layers of the diaphragm.

Roentgenograms on May 8 following a barium enema (Fig. 4 and 5) showed that the column of barium passes without obstruction or delay from the rectum to the splenic flexure. At this point the haustral markings become very prominent simulating spasm with partial occlusion of the lumen. There is mild hyperactivity of the colon. There are multiple translucent filling defects throughout the ascending

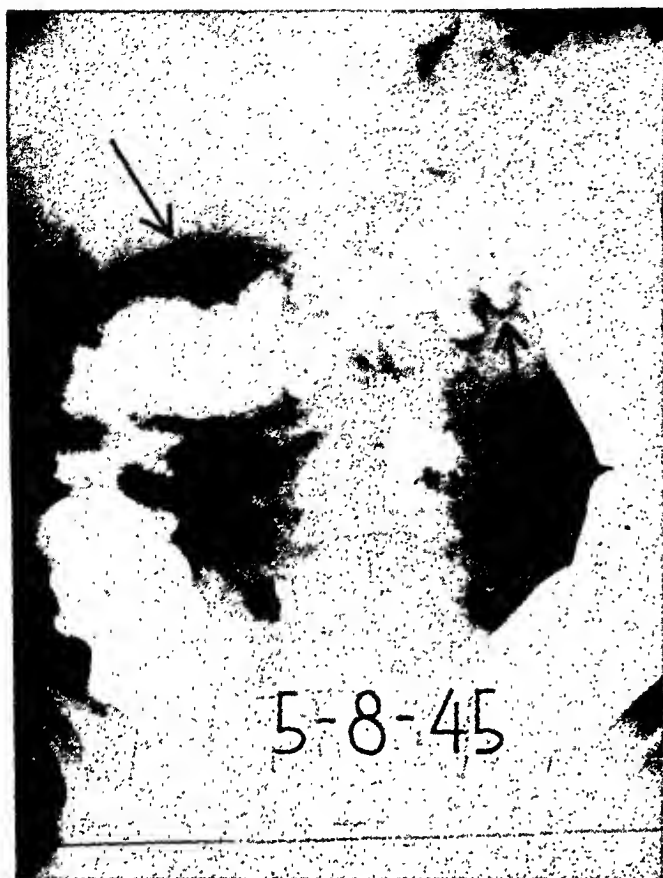


FIG. 4. The arrow in the right upper quadrant points to the dissecting gas in the region of the liver. The other arrows point to gas accumulated in the bowel wall. Note the extension of the gas from the cecum to the splenic flexure as compared to Figure 2 where it was localized to the cecum and ascending colon.

and transverse colon. These can be manipulated under the roentgenoscope so that they change slightly in shape and position. On the flat roentgenogram they are found to be due to accumulations of gas, some of which has escaped into the retroperitoneal tissues.

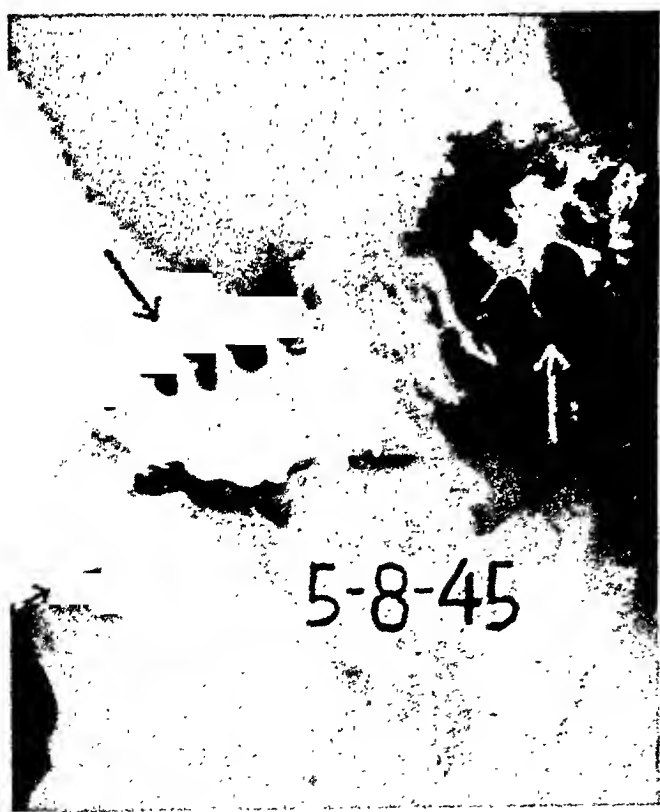


FIG. 5. Barium enema, emptying film. Arrows point to the gas in the wall of the colon and in the retroperitoneal planes. Note the appearance of spasm due to encroachment of the lumen by the accumulation of gas. There was no spasm present during the roentgenoscopic examination at this time.

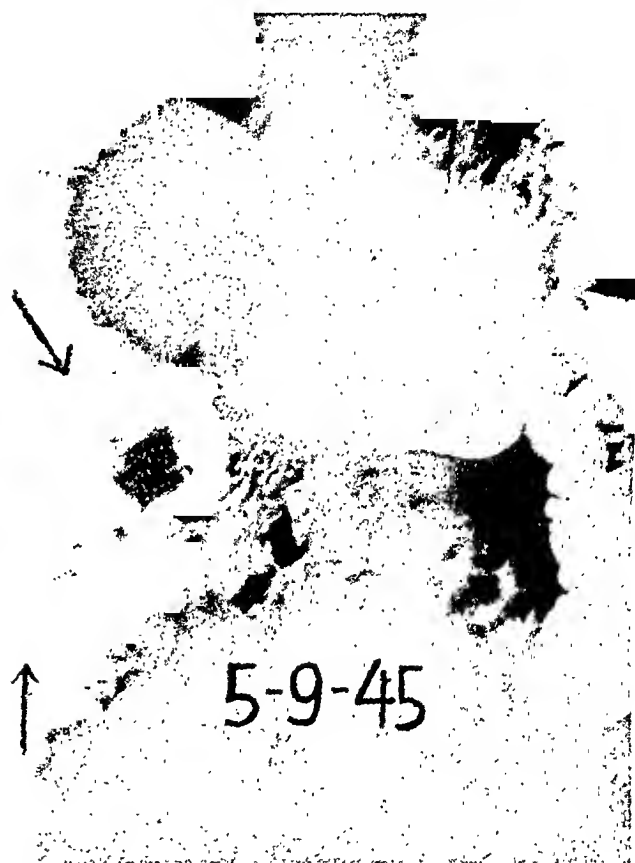


FIG. 6. Upper gastrointestinal series. The arrow in the left upper quadrant points to the gas in the retroperitoneal spaces behind the stomach. The gas is also still present in and about the right half of the colon.

A gastrointestinal examination on May 9, 1945 (Fig. 6) showed the following: The stomach and small bowel are apparently normal. On the roentgenograms there still can be seen a considerable amount of gas in the region of the ascending and transverse colon. Some of the gas is in the wall of the bowel, encroaching on the lumen and some lies outside of the limits of the bowel wall. There is a small amount of gas present in the retroperitoneal tissues behind and lateral to the stomach extending upward to the region of the diaphragm.

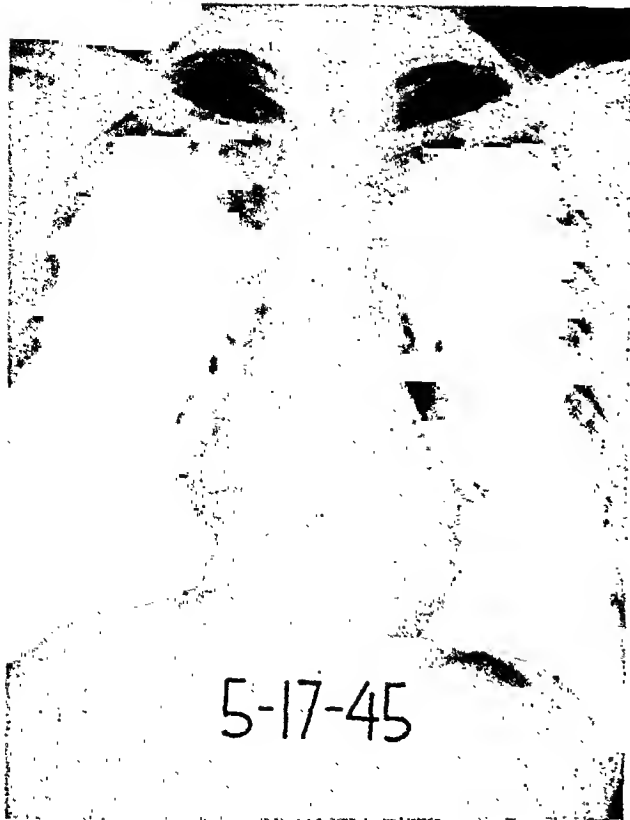


FIG. 7. The gas is no longer present in the region of either leaf of the diaphragm.

On a roentgenogram of the chest made on May 17 (Fig. 7) the previously noted gas between the layers of the diaphragm is no longer visualized.

In the examination on May 18 following a barium enema (Fig. 8) the column of barium passes from the rectum to the cecum without obstruction or delay. The contour of the bowel is normal and there is no gas visualized in or about the colon. The prominent haustral markings which were noted on the first barium enema are now shown to be artifacts. They were due to the invagination of the mucosa produced by the accumulations of gas beneath the serosa. Gas is no longer visualized in the retroperitoneal spaces in the region of the colon, stomach or diaphragm.

During the patient's stay in the hospital, the pain and the mass in the right lower quadrant disappeared. The patient appeared to make a complete recovery and was discharged on May 26, 1945.

SUMMARY

A case of pneumatosis intestinalis with extension of the gas into the retroperitoneal spaces and into the layers of the diaphragm is reported. No definite etiologic factor was established. It is possible that the use of

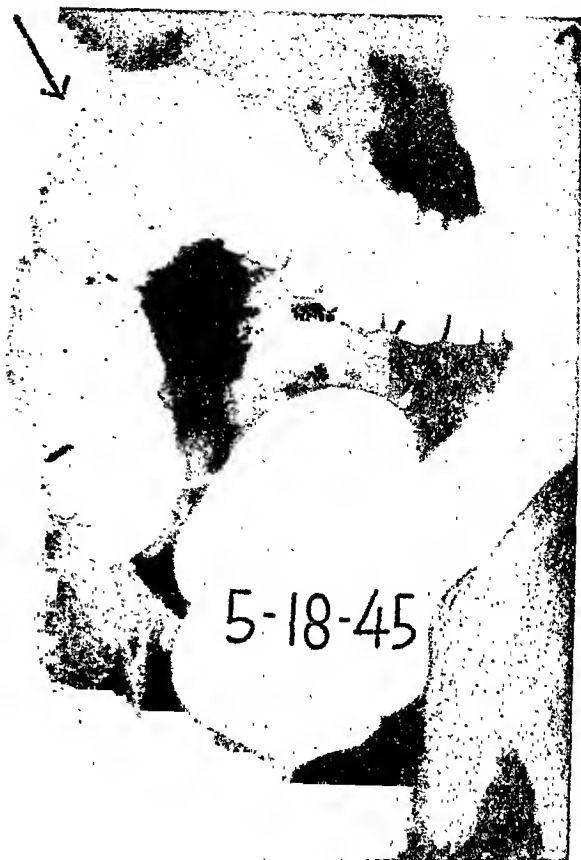


FIG. 8. The entire colon has now returned to normal. The haustral markings should be compared to those seen in Figures 4 and 5. There is a suggestion of a small amount of gas still present in the region of the hepatic flexure.

cathartics in this patient was responsible for the extensive dissection of the gas during the period of observation.

The symptoms of intestinal obstruction which were manifested in this patient gradually subsided so that surgical intervention was unnecessary.

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REFERENCES

1. BANG, *Nord. med. ark.*, 1876, 8, 18. Quoted from Jackson.²
2. JACKSON, J. A. Gas cysts of the intestine. *Surg., Gynec. & Obst.*, 1940, 71, 675-678.
3. NITCH, A. R., and SHATTOCK, S. G. Diffuse emphysema of intestinal wall (two cases) with remarks upon pneumatosis. *Proc. Roy. Soc. Med.*, 1918-1919 (*Sect. Path.*), 12, 46.
4. LINDSAY, J. W., RICE, E. C., and SELINGER, M. A. Penumatosis cystoides intestini in an infant. *Arch. Path.*, 1940, 30, 1085-1088.

SECONDARY MYELOFIBROSIS WITH PROGRESSIVE GENERALIZED OSSEOUS EBURNATION*

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A PART from primary myelofibrosis, a fairly widespread fibrosis of the bone marrow may occur in association with a number of diseases. Rosenthal and Erf²⁰ mention atypical Paget's disease, myeloma, neoplastic osteal processes, bone metastasis from carcinoma of the prostate, septicemia, benzene and radiation poisoning. To this list of secondary bone marrow fibrosis may be added hyperparathyroidism, the various granulomatoses and "spent" polycythemia. In addition to the distinctive individual features, the lesion may in one phase or another show the common histopathologic feature of fibrous replacement of bone. However, the majority of the patients afflicted with the above-mentioned disorders do not present the clinical picture of myelofibrosis. It is only exceptionally that one meets in the above disease entities the classical syndrome of secondary myelofibrosis.

Clinical myelofibrosis has two prerequisite elements. The first is destruction of a substantial portion of the blood-forming bone marrow and its replacement by a connective tissue derivative, usually fibrous tissue. The second necessary element is an attempt at compensatory hyperplasia by the remaining hemopoietic tissue, inclusive of the extramedullary potential hemopoietic organs. The spleen undergoes metaplasia and resumes its bloodforming function. Less frequently and to a lesser degree the liver shows similar metaplasia. Weakness, bone pains, splenomegaly and refractory anemia—the salient manifestations of myelofibrosis—are directly predicated upon these two basic processes of bone marrow replacement and the recruitment of all available resources for the production of blood constituents. The latter process of

hyperplasia and metaplasia expresses itself in varying hemograms. The compensatory attempt may go on to produce a myeloid leukemoid reaction. The more common hemogram consists of a normo- or microcytic anemia with polychromatophilia, anisocytosis, a varying number of erythroblasts and some immature cells of the myelocytic series.

Both primary and secondary myelofibrosis may occur with or without osseous changes. According to Rosenthal and Erf about 50 per cent of the patients with myelofibrosis show on roentgen examination mottled rarefactions or irregular condensations in the cortical portions of the bones and splintering or elevations of the periosteum. Diffuse osteosclerosis is found in only a small percentage of myelofibrosis cases.

The occurrence of myelofibrosis and diffuse osteosclerosis secondary to widespread bone metastases from prostatic carcinoma has been reported twice in the English literature. Weber²⁷ in 1929 first reported such a case under the title of "Osteosclerotic Anaemia or Leukaemia." Later upon review of the microscopic slides the correct diagnosis of diffuse osseous metastatic carcinoma from the prostate was established. The patient was a fifty-six year old man whose course lasted one year. The symptomatology consisted of weakness, anemia, tenderness and pain in bones, occasional epistaxis and hypochlorhydria. During life, by rectal examination the prostate had been noted to be hard but small. At autopsy to the naked eye the prostate had not appeared abnormal. The author included illustrative roentgenograms of generalized condensation of the pelvis and upper femora.

* From the Tumor Service, Veterans Administration Hospital, Washington, D. C. Published with the permission of the Medical Director of the Veterans Administration, who assumes no responsibility for the opinions expressed or conclusions drawn by the authors.

In 1931 O'Crowley, Trubek and Goldstein¹⁷ reported the second case. A forty-nine year old man whose first complaint was pain in the lower extremities and hips three months before his death. Rectal examination had failed to disclose a large prostate. Roentgenograms revealed diffuse osteosclerosis of homogeneous distribution involving all the bones examined. The article contains illustrations of the ribs, pelvis and lumbar spine.

In 1938 Swenson and Holzman²⁴ described a case which may belong to this group. Their patient was a thirty-six year old man who presented himself with the symptoms of weakness, anorexia, pallor, and pain in the back of one month's duration. Roentgenograms of the spine at that time showed slight decalcification with a peculiar ground-glass appearance. Terminally, one year later, the roentgenograms of the spine and pelvis revealed a diffuse homogeneous increase in density. Post-mortem examination disclosed the condition to be the result of an unusual osteoblastic skeletal reaction to widespread carcinomatous metastases from an undetermined primary site. All organs examined including the stomach and one-half of the prostate were negative. The other half of the prostate was left in the body unexamined. The authors mentioned the possibility that their case belonged to the group described by Jarcho,¹⁵ in which metastases usually from a primary scirrhous carcinoma of the stomach in a young adult spreading via lymphatics, were associated with thrombocytopenic purpura and anemia. Jarcho did not mention the roentgenographic skeletal findings in these cases.

In the non-English literature Putti and Faldini¹⁹ reported a case which roentgenographically closely resembled ours. The case of Vignoles and Imhoff,²⁶ and the last 2 cases of del Solar, Diaz and Ovalle⁷ probably also belong to this group.

The following report represents an additional case characterized by secondary myelofibrosis with progressive generalized osseous eburnation.

REPORT OF CASE

E. V., male, aged fifty-five, was admitted on February 26, 1945 to the Mt. Alto Veterans Hospital.

Chief Complaints. Pain in all joints; failing vision and pain in the left eye; bloody urinary discharge.

Family History. Mother died at ninety-two of "old age." Father died at seventy-two of a "spine condition." Wife and two children are living and well. Two children died in infancy.

Past History. In 1930 he had a submucous nasal resection. Since then there has been plugging of the nasal chambers with occasional extrusion of bloody clumps. In 1933 while pruning a tree the patient sustained an injury to his left eye with temporary blindness. This resulted in defective vision in his left eye. In 1936 a diagnosis of undulant fever was made. Ever since he has had bouts of fever several times a year, especially in the spring. His occupation has been that of a farmer, which included the care of sheep. On occasions he handled the usual insecticide sprays and powders. During his Army service he was stationed (1912-1917) in the Philippines, China and Japan. Venereal diseases are denied by name and symptoms. For at least twenty-five years the patient was in the habit of consuming excessive amounts of water. He would drink four to five glasses of water with each meal and additional quantities in between. The urinary output was correspondingly large.

Present Illness. In September, 1943, the patient first noted slowness of his urinary stream. Soon thereafter pain and swelling of all his joints set in, associated with progressive weakness and anemia. He was then sounded and a stricture of the urethra was found. Reference to records at another hospital revealed that the prostate was moderately enlarged with some hard areas in it. With the possibility of a prostatic malignancy in mind, his physician placed the patient on stilbestrol therapy. The marked secondary anemia was treated with whole blood transfusions—thirteen in all between May, 1944, and February, 1945. At another institution irradiation was administered in a vain attempt to alleviate the bone pains. During June, July and August, 1944, he received 2,175 r to the posterior lumbar region, 1,500 r to the lateral aspect of the right hip, 900 r to the anterior left hip, 1,050 r to the lateral left hip, and 600 r to the anterior right shoulder. The exposure

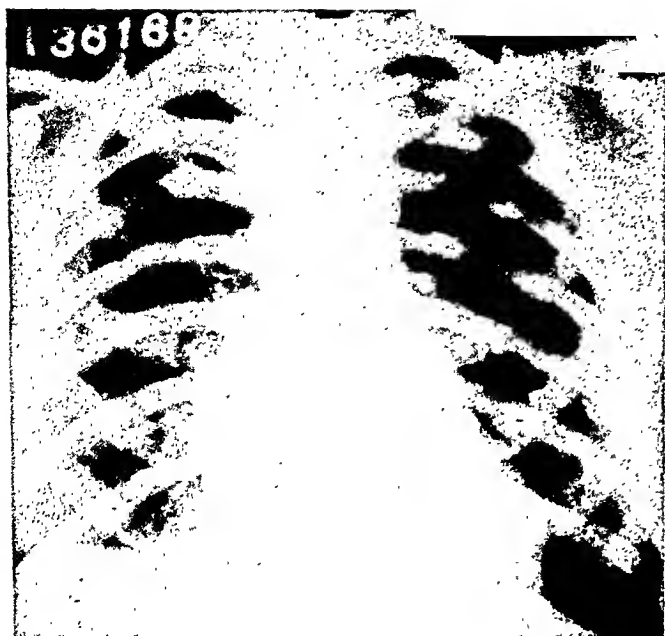


FIG. 1. Roentgenogram of the chest shows diffuse condensation of the clavicles and all the ribs. Their cortical margins cannot be clearly distinguished inasmuch as they merge with the general density of the marrow cavity. The axillary segment of the right sixth rib was resected for biopsy.

factors were 200 kv., 50 cm. distance, 15 by 20 cm. fields, Thoraeus filter.

The joint pains, the frequency and the nocturia continued. Occasionally he would pass frank blood in his initial stream, "coming from the penis" according to the patient. In January, 1945, additional symptoms manifested themselves. The patient began to experience left-sided frontal headaches, left periorbital

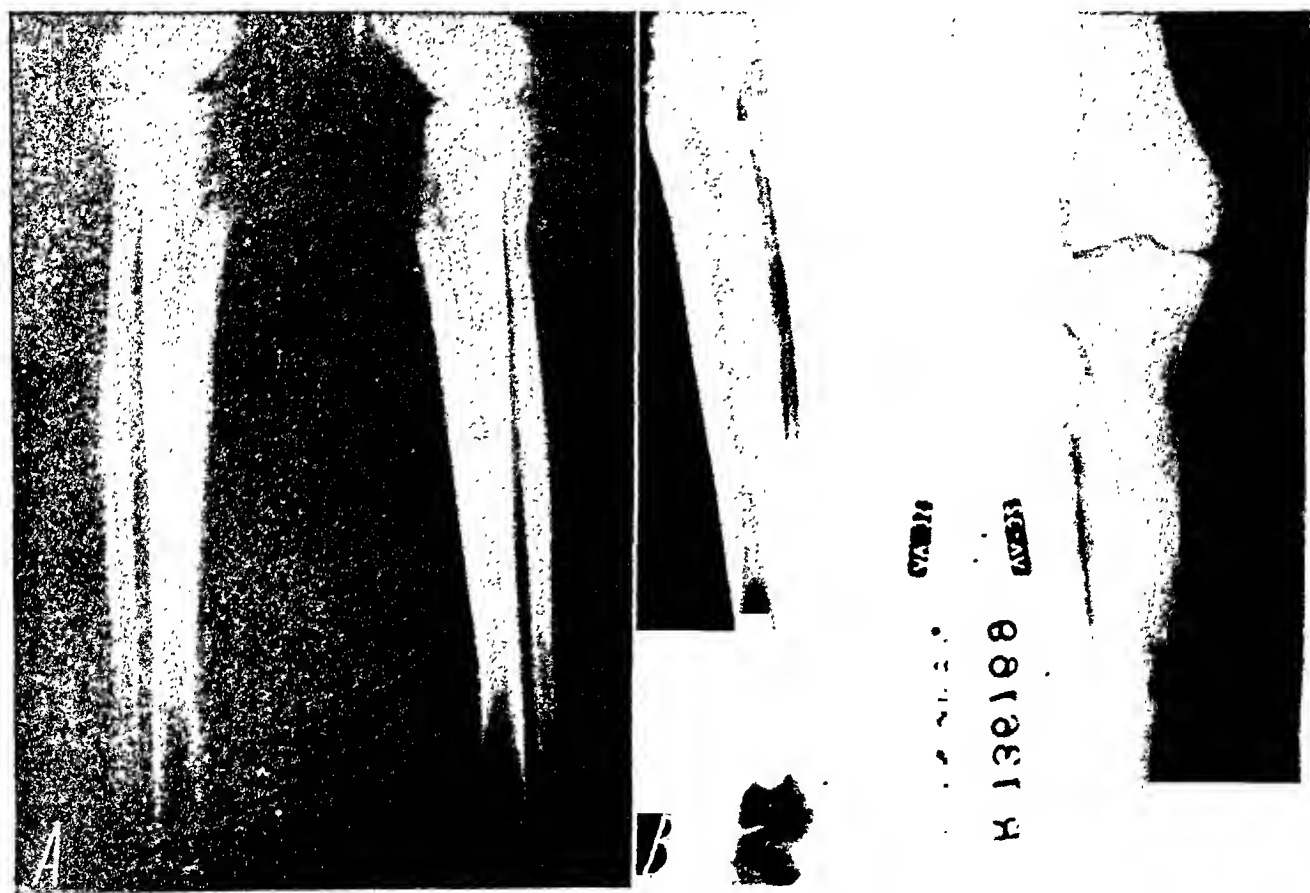


FIG. 2. *A*, lateral views of both legs taken on May 15, 1944, show normal bony architecture and density. (This roentgenogram was courteously supplied by Dr. H. Tuttle Stull, roentgenologist to the Suburban and Arlington Hospitals.) *B*, anteroposterior view of right leg and lateral view of the left leg roentgenographed March 17, 1945; the latter was taken with somewhat greater penetration. The tibiae reveal widening and thickening of the cortical portions with encroachment upon the marrow cavity. Note that the general contour of the tibiae has not been disturbed. The predilection of the metastatic eburnation to begin and attain maximum density at the extremities of the long bones is well illustrated in these roentgenograms.



FIG. 3. *A*, lumbar spine and pelvis taken May 12, 1944, disclose diffuse condensation. (Courtesy of Dr. H. Tuttle Stull, roentgenologist to the Suburban and Arlington Hospitals.) *B*, lumbar spine and pelvis taken on April 27, 1945, reveal the maximum degree of eburnation to have been attained by the lumbar vertebrae. The sacrum and the innominate bones also increased in density during the interval.

numbness, blurring of the left lower visual field, and pain in his left eye with rapidly increasing blindness. He further noted almost complete suppression of saliva. Some diminution in the amount of saliva had been present for almost a year. Anorexia set in and he sustained a loss in weight amounting to 30 pounds in six months.

Physical Examination. Upon admission the patient was found to be an acutely and chronically ill man, bedridden and in very poor general condition. The skin was sallow. The left eye was practically blind—only finger perception; there was paresis of the left external rectus muscle. Heart and lungs were negative to percussion and auscultation. Blood pressure 120/60. Pulse 120, respiration 30, temperature 101° F. The spleen could not be felt. The wrists, knees, ankles, and especially the metatarsophalangeal, the metacarpophalangeal, and the proximal interphalangeal joints of the fingers were markedly tender, moderately swollen, and at times red. Clinically they were suggestive of rheumatoid arthritis. Pretibial edema one to

two plus. The prostate was enlarged but not stony hard.

Laboratory Data. Blood count: hemoglobin 58 per cent; erythrocytes, 2,150,000; color index, 1.3; leukocytes, 5,200, with 62 per cent polymorphonuclears, 34 per cent lymphocytes, 2 per cent monocytes, and 2 per cent eosinophiles. Much variation in size, shape and staining qualities of the red blood cells. Sedimentation rate, 73 mm. in half hour. Blood Wassermann reaction, negative. Serum albumin 3.6, globulin 4.3. Nonprotein nitrogen 21.9, uric acid 4.2. Blood sugar 112. Agglutination for *B. tularensis* and *Brucella abortus* were negative. Acid phosphatase 0.0 to 0.2 (normal 0.0 to 1.1); alkaline phosphatase 21.5 to 26.4 (normal 2 to 9). Gastric acidity: total 15, free HCl 0. Urine essentially negative, except for red blood cells when patient had urethral bleeding.

Roentgenograms showed diffuse condensation of the clavicles and all the ribs (Fig. 1). Their cortical margins could not be distinguished inasmuch as they merged with the general density of the marrow cavity. The skull

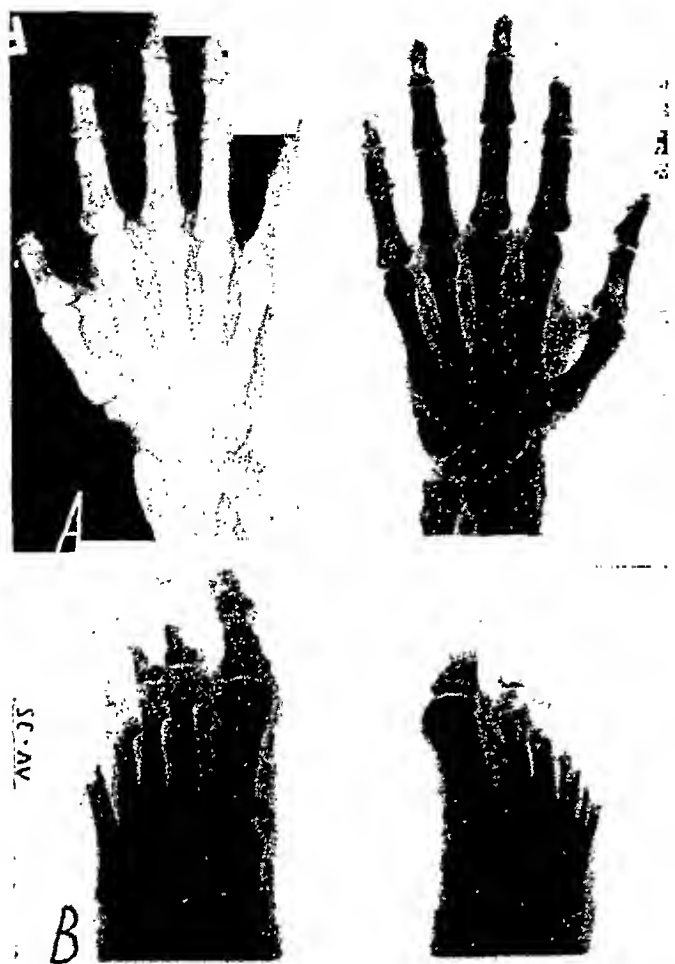


FIG. 4. *A*, roentgenograms of the wrists and hands in a case of secondary myelofibrosis with progressive generalized osseous eburnation due to metastases from a carcinoma of the prostate. The distal extremities of the radii, all the carpals, and the metacarpals show diffuse condensation. Patchy osteosclerosis is also seen in the phalanges. *B*, both feet present diffuse condensation of the metatarsals. The shaft of the right first metatarsal exhibits erosion of the cortex associated with a slight degree of periosteal reaction.

exhibited slight thickening of the diploe; the tables were within normal limits. There was a generalized increase in the density of the sphenoid bone, the mandible, the scapulae, ilia, and femora. The tibiae presented widening and thickening of the cortical portions with loss of distinctness and encroachment upon the marrow cavity. The general contour of the femora and tibiae was unaffected. Marked eburnation had taken place at the extremities of both femora and tibiae. The proximal as well as the distal extremities of the long bones (Fig. 2)

exhibited this predilection for eburnation. In addition, the entire spine from the first cervical to the third sacral was of ivory consistency. The maximum degree of eburnation was attained by the lumbar vertebrae (Fig. 3). The distal extremities of the radii, all the carpals, the metacarpals, and the bases of the metatarsals showed diffuse increase in density (Fig. 4). Roentgenograms taken with greater penetration revealed more opaque patches scattered in the dense bones about the wrist joint. Mottled condensations were found in the talus and naviculae of each foot and all the phalanges of both hands. The shaft of the right first metatarsal presented erosion of the cortex with slight periosteal reaction. Similar periosteal reaction of slight degree was noted in the right first metacarpal.

Course. On the twelfth day after admission proptosis of the left eye was noted. The exophthalmometer gave readings of 17 mm. for the right and 22 mm. for the left eye. This was associated with chemosis and anesthesia of the left periorbital and temporal region. On March 26, 1945, the left orbit was explored. No pus or orbital tumor was found. The severe anemia required weekly transfusions. Subsequent blood counts showed some myelocytes and a few nucleated red blood cells and a color index which varied between 1.15 and 0.74.

On March 30 a 3 inch biopsy of the right sixth rib was taken. Grossly it showed an ivory-like cortex with a markedly increased resistance to sawing. The marrow cavity was completely obliterated by dense hard bone which could not be scraped out. On microscopic examination the bone trabeculae were found increased in width and in number (Fig. 5*A*). They exhibited a dense lamellar structure as seen in compact bone. The wavy linear condensations of calcium, in general following the contour of the lamellae, suggested concentric accretions of the trabeculae. The lacunae and the bone cells within them appeared normal. Multiple linear deposits of calcium were also found near the surface of many trabeculae. There were no lining osteoblastic cells, nor were osteoclasts to be found. The marrow spaces were relatively decreased in size. The bone marrow in general was almost completely replaced by a diffuse fibrosis, so that only a few marrow cells remained. In only a few areas were scattered infiltrating foci of highly anaplastic epithelial tumor consistent with the diagnosis of



FIG. 5. *A*, rib biopsy. Photomicrograph ($\times 75$) (Army Medical Museum negative No. 89450). The bone trabeculae are increased in width and in number. They exhibit a dense lamellar structure. Note the wavy linear condensations of calcium, in general following the contour of the lamellae, suggesting concentric accretion of the trabeculae. There are no lining osteoblasts, nor osteoclasts. In the lower left hand corner can be seen the fibrous replacement of the bone marrow elements. In the center is a focus of infiltrating tumor cells. *B*, higher magnification ($\times 450$) photomicrograph. (Army Medical Museum negative No. 89449). Highly anaplastic metastatic epithelial tumor cells are seen in the marrow space, consistent with the diagnosis of a primary carcinoma of the prostate. The cells are polyhedral containing round vesicular nuclei showing a great deal of hyperchromatism. The cytoplasm of many of the cells appears foamy and vacuolated.

a primary carcinoma of the prostate (Fig. 5*B*). These metastatic foci consisted of polyhedral cells containing round vesicular nuclei showing a great deal of hyperchromatism. The cytoplasm of many of the cells appeared foamy and were vacuolated. The arrangement of the cells imparted the suggestion of alveolar formation.

Chemical analysis of the rib bone yielded: Ash, 63.14 per cent of the dried specimen (normal 58.80); calcium, 0.32 mg. per 1 mg. of bone ash (normal 0.22). The lead content was normal. No fluoride, arsenic or bismuth was found.

The patient ran an irregularly febrile course, ranging from 99 to 102° F. On April 5, 1945, he developed a left parotitis. The spleen became palpable on April 23. Rectal examination on April 27 disclosed an enlarged prostate of hard consistency. The patient had been off stilbestrol therapy for at least two months. The anemia was progressive despite continued

weekly transfusions. The patient rapidly grew weaker and died on May 18, 1945. Permission for autopsy was refused.

COMMENT

From the roentgenologic viewpoint several diseases have to be considered in the differential diagnosis of diffuse bone condensation.

1. *Osteopetrosis*. This disease occurs in a much younger age group. The skull is usually involved and heavily so. Any area of bone under examination will show a continuous density of approximately the same degree except at the periphery of the involved area. A history of consanguinity may be obtainable.

2. *Melorheostosis*. The "flowing wax"

appearance is characteristic of this disease.

3. *Osteopoikilosis*. This developmental anomaly consists of numerous dense bone islands. The skull is spared. Phalen and Ghormley¹⁸ reported a case having some of the features of osteopoikilosis, osteopetrosis and melorheostosis.

4. *Syphilis*. The sclerosing osteitis of lues is usually localized. It involves one, two or three bones. Francis and Kampmeier⁸ described 117 bone lesions of all types, inclusive of luetic periostitis and gummatous osteomyelitis in 67 patients—an average of two lesions per patient.

5. *Lymphoblastoma*. In this group, too, the lesions are confined to several bones and most often only to parts of bone. Lymphosarcoma manifests itself almost entirely by osteolytic lesions. In Hodgkin's disease only 12 per cent are purely osteoblastic, found mostly in the lumbar vertebrae.²⁵ The average is less than four bones involved per patient. Craver and Copeland⁶ reported bone changes in 6 out of 86 cases of lymphatic leukemia. These changes consisted of elevation of the periosteum due to infiltration beneath it. This was occasionally followed by osteosclerosis from proliferation of new bone. Extensive generalized osteoporosis may sometimes be present without localized areas of destruction. Snelling and Brown²³ reported bone changes in some stage of the disease in 8 out of 12 children. Their most consistent finding was a rarefied area near the end of the bone adjacent to the epiphyseal line together with elevation of the periosteum. Roentgenographic bone involvement in myelogenous leukemia is extremely rare.

6. *Poisons*. The eburnation of the extremities of the femora, tibiae and radii suggested the possibility of phosphorus, lead, fluoride and radium poisoning. Chemical examination of the rib was negative. Holm¹¹ emphasizes the point that phosphorus osteosclerosis occurs only when a process of ossification is going on. It, therefore, is not seen to originate later in life after completion of skeletal growth. No radioactivity of the patient could be dem-

onstrated. Radiation osteitis did not enter into consideration in this case. The bone lesions existed prior to irradiation and were found in regions not exposed to irradiation. Besides, in radiation osteitis there is usually a central or off-center osteolytic element.

7. *Paget's Disease*. This is the most likely entity with which metastatic carcinoma of the prostate may be confused. In its characteristic form Paget's disease presents areas of condensation alternating with irregular zones of rarefaction. The cortex of the long bones shows marked thickening and longitudinal fibrillation. The most distinguishing feature is the deformity of the outer bony contour. The rapid progression of the osteosclerosis (Fig. 2) is definitely against Paget's disease.

8. *Metastatic Carcinoma of the Prostate*. In the majority of cases both osteolytic and osteoblastic metastases occur. Huggins¹³ found only 2 out of 31 to be purely osteolytic. In these 31 patients with advanced prostatic carcinoma he never encountered metastases distal to the knee or elbow joints. Geschickter and Maseritz¹⁰ listed no foot or hand metastases in a series of 1,041 cases of carcinoma of the prostate, and only 1 involving the humerus, 1 the clavicle, 1 the tibia, 1 the scapula, and 2 the ribs. The 6 patients with advanced and widespread osseous metastases from carcinoma of the prostate recently seen by us failed to show any lesions below the knees and elbows. Lanari and Jorg¹⁶ described a case of Paget's disease with condensation of the distal epiphyses of both femora and proximal and distal epiphyses of both tibiae. The involvement of the hands and feet in Paget's disease is equally rare. Brunner³ mentioned only 1 case out of 26 patients with Paget's disease with metatarsal and phalangeal lesions. On the basis of the clinical findings, the rib biopsy and the roentgenographic manifestations, the patient constituting the subject of our report is presented as a case of myelofibrosis secondary to a carcinoma of the prostate with the unusual features of

metastatic osseous condensations in the limbs distal to the elbows and knees.

The mechanism of new bone formation in prostatic skeletal metastasis has as yet not been settled. Sharpe and McDonald²² stated that the degree of malignancy had no bearing on the amount of new bone formation. The only correlation they could find was as to the amount of new connective tissue deposition. Putti and Faldini¹⁹ found three types of bone changes: namely, fibrotic transformation of the medulla, areas of metaplastic ossification of the cartilage and areas of new bone formation. Brunschwig,⁴ on the other hand, concluded that there was no evidence for metaplasia into osteoblasts and other mesoblastic elements within the marrow and in the soft parts immediately overlying the cortex. He favored the concept that new bone in intramedullary osteoblastic metastasis is the result of a combination of two factors varying in relative importance. These are: (a) infarction of the cortex and marrow resulting in endosteal stimulation due to reduced circulation. Infarction may also produce aseptic necrosis of bone and this is followed by creeping replacement of the dead bone by living bone; (b) direct stimulation of endosteal osteoblasts. This is in accord with Huggins' suggestion that prostatic epithelium also has "osteogenic" properties analogous to that of urinary bladder epithelium. No experimental proof for these "osteogenic" properties of prostatic epithelium has as yet been presented. No bone formed in the prostatic transplants as did in the bladder transplants. On the clinical side, Schmorl²¹ described the only case of bone formation in soft tissue metastasis of carcinoma of the prostate. Ashburn¹ reported 1 case of carcinoma of the prostate with a nodule of bone in the prostate, 10 by 14 mm. intimately associated with tumor cells. Huggins¹² made no mention of the prostate in his list of heterotopic bone formation.

A third factor commonly quoted among the hypotheses of new bone formation is that of a "defense reaction" to a foreign

body or noxious element. The presence of metastatic condensations in the hands and feet cannot be explained on Cave's⁵ hypothesis that stimulation of the sympathetic fibers by adjacent involved lymph nodes causes vasoconstriction with consequent osteosclerosis. Even if this were true in the lumbar region no such anatomical correlation obtains in the hands or forearms. No enlarged lymph nodes could be demonstrated in the regions of the cervical sympathetic ganglia or along the course of the sympathetic fibers to the upper extremities. Similarly, because of anatomical considerations one cannot invoke Batson's² vertebral system of veins to account for the spread of metastases to the bones about the wrists and knees. Batson does not claim any connection between this vertebral system of veins and the veins of the extremities. The predilection of the bone condensation to begin at and attain the greatest density in the extremities of the long bones—the region best supplied with blood—suggests a blood stream spread. This is at variance with Geschickter's⁹ opinion that spread via the lymphatics causes osteoplasia, via blood stream—osteoclasia. Besides, no lymphatic vessels have as yet been demonstrated in bone. Putti and Faldini,¹⁹ after a careful gross and microscopic study, could not find any involvement of the muscles and soft tissues of the extremities and their lymphatics. Only in the immediate vicinity of the osseous cortex at the muscle insertion were several small neoplastic nodules discovered. These authors concluded that the neoplasm was first generalized through the lymphatics, thence through the blood stream it reached the skeleton, where it was detained by a biochemical or cellular affinity. The predilection of the metastases for the extremities of the long bones may be correlated to the distribution of red marrow in the adult. Willis²⁸ noted that "metastatic growths in bone are almost invariably situated in red bone marrow. In patients with cachectic anemia, especially that due to metastatic growth in bones, the distribu-

tion of red marrow may depart widely from the normal. Compensatory erythropoiesis results in the replacement of areas of yellow marrow by hyperplastic red marrow, and metastatic growth may then be found in these situations. Thus, although in healthy adults the middle and lower third of the humerus and femur and most of the bones of the distal segments of the limbs contain only fatty marrow, metastatic growths in these situations are found almost invariably to be situated in red marrow. The much greater vascularity of red bone marrow as compared with yellow marrow is at least partly responsible for the much greater frequency of metastases in the former, but it may also be that red marrow is an intrinsically better soil than yellow marrow for establishment of metastatic growth." The finding of metastatic bone condensations in the tibiae, radii, carpal, metacarpal, tarsal, and metatarsal bones in our patient are in consonance with the above-quoted concepts of Willis. The compensatory hemopoiesis attempting to combat the marked anemia of myelofibrosis most likely resulted in red marrow transformation and thus prepared the soil and the vascularity for the deposition of metastatic foci in the segments of the limbs distal to the elbows and the knees.

The high serum alkaline phosphatase in this case is in accordance with the active new bone formation. The normal limits of the acid phosphatase values prior to stilbestrol therapy may or may not be of significance. Huggins and Hodges⁴⁴ stated that no deduction could be made from the enzyme study of the serum with respect to the osteoblastic or osteolytic nature of the metastatic lesions. Out of 25 cases of carcinoma of the prostate with skeletal metastases they found 6 with a normal acid phosphatase.

SUMMARY

1. A case of secondary myelofibrosis with progressive generalized osseous eburnation due to skeletal prostatic carcinoma

metastases is presented. Only two similar cases were described in the English literature.

2. The prognosis in such cases is worse than in the average carcinoma of the prostate. The course varies between one and one and one-half years.

3. The differential diagnosis of diffuse bone condensation includes osteopetrosis, melorheostosis, osteopoikilosis, syphilis, lymphoblastoma, poisons (lead, phosphorus, fluoride, radium), radiation osteitis, Paget's disease and metastatic carcinoma.

4. Clinical myelofibrosis has two prerequisite elements; namely, destruction of bone marrow and an attempt at compensation by the remaining hemopoietic tissue, inclusive of metaplasia in spleen and liver. The cardinal symptoms are weakness, bone pains, a varying degree of splenomegaly and a refractory anemia with nucleated red blood cells and immature white blood cells in the peripheral blood.

5. Histopathologically the involved bone shows an increase in width and number of the trabeculae with linear calcium deposition. The lamellae present normal lacunae and bone cells. A conspicuous feature is the scarcity or complete absence of lining osteoblasts and osteoclasts. This may be due to the fact that we are seeing the end-result in the already dense bone rather than the active phase of bone formation in the condensing bone. The marrow spaces contain fibrous tissue with sparsely scattered infiltrative foci of tumor cells.

6. This patient presented the additional unusual features of proptosis of the left eye, metastases to the bones of the hands and feet which symptomatically and objectively resembled rheumatoid arthritis, and in the limbs a predilection of the osteosclerosis to begin at and attain greatest density in the extremities of both humeri, radii, femora, and tibiae. The findings of metastatic osseous condensations in the bones below the elbows and knees may be predicated upon the prior transformation of the yellow into red marrow in the body's

attempt at compensatory hemopoiesis to combat the marked anemia of his myelofibrosis.

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REFERENCES

1. ASHBURN, L. L. New bone formation in a primary carcinoma of prostate gland. *Arch. Path.*, 1939, 28, 145-150.
2. BATSON, O. V. Function of vertebral veins and their role in the spread of metastases. *Ann. Surg.*, 1940, 112, 138-149.
3. BRUNNER, W. Osteodystrophia deformans Paget, unter besonderer Berücksichtigung Erfahrungen der letzten 10 Jahre. *Deutsche Ztschr. f. Chir.*, 1939, 252, 585-603.
4. BRUNSCHWIG, A. Reaction of bone to invasion by carcinoma. *Surg., Gynec. & Obst.*, 1936, 63, 273-282.
5. CAVE, P. Osteoplastic metastases. *Brit. J. Radiol.*, 1933, 6, 69-84.
6. CRAVER, L. F., and COPELAND, M. M. Changes of the bones in leukemias. *Arch. Surg.*, 1935, 30, 639-646.
7. DEL SOLAR, A., DIAZ, F., and OVALLE, U. I. Sobre metastasis osteoplásticas generalizadas. *Rev. méd. de Chile*, 1944, 72, 66-71.
8. FRANCIS, H. C., and KAMPMEIER, R. H. Bone lesions in acquired tertiary syphilis. *South. M. J.*, 1943, 36, 556-559.
9. GESCHICKTER, C. F. Roentgenologic diagnosis of bone tumors. *Radiology*, 1931, 16, 111-180.
10. GESCHICKTER, C. F., and MASERITZ, I. H. Skeletal metastasis in cancer. *J. Bone & Joint Surg.*, 1939, 21, 314-322.
11. HOLM, O. F. Contribution to the knowledge of the origin of phosphosclerosis. *Acta radiol.*, 1942, 23, 549-561.
12. HUGGINS, C. B. Formation of bone under influence of epithelium of the urinary tract. *Arch. Surg.*, 1931, 22, 377-408.
13. HUGGINS, C. Diagnosis of cancer of the prostate including interpretation of some phosphatase values. *Bull. New York Acad. Med.*, 1943, 19, 195-200.
14. HUGGINS, C., and HODGES, C. V. Studies on prostatic cancer. *Cancer Research*, 1941, 1, 293-297.
15. JARCHO, S. Diffusely infiltrative carcinoma; hitherto undescribed correlation of several varieties of tumor metastasis. *Arch. Path.*, 1936, 22, 674-696.
16. LANARI, E. L., and JORG, M. E. Sobre un caso de osteosclerosis sistemática. *Radiología*, 1942, 5, 101-107.
17. O'CROWLEY, C. R., TRUBEK, M., and GOLDSTEIN, H. H. Osseous metastasis in carcinoma of the prostate. *J. Urol.*, 1931, 26, 665-680.
18. PHALEN, G. S., and GHORMLEY, R. K. Osteopathia condensans disseminata associated with coarctation of the aorta. *J. Bone & Joint Surg.*, 1943, 25, 693-700.
19. PUTTI, V., and FALDINI, G. Diffuse osteoplastic carcinosis of the skeleton from primary carcinoma of the prostate—clinically unrecognized. *Chir. d. org. di movimento*, 1930, 14, 505-529.
20. ROSENTHAL, N., and ERF, L. A. Clinical observations on osteopetrosis and myelofibrosis. *Arch. Int. Med.*, 1943, 71, 793-813.
21. SCHMORL, G. Quoted by Ashburn.¹
22. SHARPE, W. S., and McDONALD, J. R. Reaction of bone to metastasis from carcinoma of breast and prostate. *Arch. Path.*, 1942, 33, 312-325.
23. SNELLING, C. E., and BROWN, A. Bone changes in leukemia; clinical and roentgenological. *Arch. Dis. Childhood*, 1934, 9, 315-318.
24. SWENSON, P. C., and HOLZMAN, G. G. Discussion of generalized osteosclerosis, with report of unusual case. *Radiology*, 1938, 31, 333-339.
25. VIETA, J. O., FRIEDEL, H. L., and CRAVER, L. F. Survey of Hodgkin's disease and lymphosarcoma in bone. *Radiology*, 1942, 39, 1-15.
26. VIGNOLES, M., and IMHOFF, J. D. Diffuse osteoplastic carcinomatosis of skeleton due to primary carcinoma of prostate. *Rev. méd. del Rosario*, 1934, 24, 539-554.
27. WEBER, F. P. Specimens from case of osteosclerotic anaemia or leukaemia. *Tr. Med. Soc. London*, 1928-1929, 52, 99-103.
28. WILLIS, R. A. The Spread of Tumours in the Human Body. J. & A. Churchill, London, 1934.



THE ROENTGEN DIAGNOSIS OF VOLVULUS OF THE SIGMOID WITH INTESTINAL OBSTRUCTION*

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INTRODUCTION

VOLVULUS of the sigmoid is an important cause of intestinal obstruction. It is a condition in which early diagnosis and the immediate institution of proper therapeutic measures are essential if the life of the patient is to be saved. In the past, the mortality in obstruction due to volvulus of the sigmoid has been extremely high, averaging approximately 40 per cent. This elevated death rate has been due principally to three factors: (1) clinical diagnosis is extremely difficult and in many cases impossible; (2) cecostomy, intubation, and similar palliative procedures customarily resorted to in the treatment of patients suffering with intestinal obstruction are unavailing in volvulus, merely resulting in delay which serves to increase the mortality and (3) prompt relief of the obstruction is necessary to prevent strangulation with consequent necrosis of the bowel, hemorrhage and shock.

Roentgen studies offer a method which enables the observer to establish the site of the obstruction and in many instances the nature of the lesion. This topic is therefore of unusual interest to the roentgenologist. It is our purpose to review the clinical manifestations which should make the clinician suspect the possibility of volvulus of the sigmoid and to describe in detail the roentgen methods of investigation by which a diagnosis may be made.

DEFINITION

Volvulus is an abnormal rotation, torsion or twisting of the intestines, at times as-

sociated with knotting of the loops. The volvulus may be a rotation of the bowel on its own axis, torsion on its mesentery, or a combination of both. Rarely, there may be intertwining with another loop of intestine.

ETIOLOGY

While not a rare condition, the incidence of volvulus of the sigmoid is not great. Sweet, in a report comprising 53 patients with intestinal volvulus, found 36 cases involving the small intestines, 6 in the cecum, and 10 in the sigmoid. Griffin, Bartron and Meyer reviewed 458 cases of intestinal obstruction from the records of the Cook County Hospital (Chicago) and found that 37 were volvulus of the sigmoid. Statistics indicate that 2-4 per cent of all bowel obstructions are due to volvulus. However, reports from Russian and Serbian sources show a much higher proportion, from 23-34 per cent of patients suffering from obstruction having an associated volvulus. This greater incidence is apparently due to dietary habits, as these peoples eat more vegetables and similar bulky foods; also, they may go for long periods with very little food and then ingest relatively large amounts at one time. Volvulus may occur at any stage of life, and is more frequent in men than in women. It is often associated with megacolon.

PATHOGENESIS

Volvulus of the sigmoid is particularly likely to occur if the sigmoid is dilated, long and redundant. These changes may be congenital or the result of chronic constipation

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and bowel stasis, which predispose to lengthening and simultaneous increase in the caliber of the gut. Retention of fecal masses favors the development of volvulus, the weight of the feces causing the heavier loops to sag and slide over a portion of the bowel which is empty or only partially filled. An associated shortening or narrowing of the mesentery may cause sharp angulation, drawing the two limbs of the sigmoid closer together and causing a volvulus; this is most apt to occur if adhesions are present between the sigmoid loops. Pressure from large pelvic masses may, similarly, force the loops of sigmoid closer together. Increased peristaltic activity associated with dietary indiscretions or resulting from the use of strong cathartic or purgative drugs is also an important factor in the production of volvulus.

The volvulus may be 180° , 360° , or more, cases having been reported with three or four complete turns. The involvement may be limited to one area of the sigmoid; frequently, however, it is a double twist with shutting off of a segment of bowel of variable length between the two areas of torsion (Fig. 2B). The rotation is more often clockwise than the reverse. The tightness of the twist is of much greater importance than its degree or direction. Not all cases result in a permanent or complete obstruction and spontaneous detorsion is apparently a not infrequent occurrence. This is evidenced by the fact that many patients give histories extending over long periods of repeated attacks of pain and distention which disappeared with rest and therapy. However, these episodes are not entirely innocuous for they doubtless cause shortening of the mesentery and adhesions, important factors in the eventual production of a volvulus which is irreducible, as indicated above.

When complete obstruction supervenes, gas and fluid are rapidly accumulated proximal to the point of stenosis or in the occluded loop with resultant distention, which in some instances is very severe in degree. The distended loops may become

many times normal size and rise out of the pelvis into the right upper quadrant or to fill the entire abdomen with upward displacement of the liver and diaphragm. Enlargement of the blood vessels produces hemorrhage into the colon causing loss of large amounts of blood and the resultant development of severe shock. Unless detorsion occurs or the obstruction is promptly relieved, strangulation ensues and necrosis may develop rapidly, within a few hours in some cases. Peritonitis is a frequent complication.

CLINICAL ASPECTS

Patients with volvulus may present a long antecedent history of constipation with repeated attacks of abdominal pain of varying severity in the past, which may properly be assumed to have been due to recurrent, mild torsions which had undergone spontaneous correction. In others, there have been no previous episodes. The acute attack is not infrequently preceded by dietary indiscretions, particularly the ingestion of large quantities of bulky foods or a purgative. The onset is usually sudden and dramatic, the severity varying with the degree of obstruction. Constipation is very marked, enemas producing little or no result. Diarrhea with blood and mucus may be present. There is no belching or flatus. Vomiting seldom occurs. The patient may go into collapse and shock. Cecostomy, intubation and similar palliative measures are unavailing. Transfusions and subperitoneal fluid may produce temporary improvement, but the patient's condition usually grows rapidly worse despite all attempts at palliation.

In the early stages, the abdominal wall may be soft and the tense sigmoid loops palpable in the pelvis and abdomen. More commonly, there is marked distention of the entire abdomen and palpation is impossible. Tenderness may or may not be present; at times, it is noted in the very early stages of strangulation and later if peritonitis has developed. Percussion varies according to the contents of the involved

loops; when distended with gas, there is tympany; if filled with fluid, there is dullness. Rectal examination gives no information of value. Sigmoidoscopy may demonstrate the lesion if the volvulus is low in the sigmoid. However, the obstruction is usually too high to be seen with the sigmoidoscope and the patient's condition may be too critical to permit of accurate observation.

ROENTGEN FINDINGS

In the study of a case of suspected volvulus of the sigmoid, the roentgen examination is best begun with survey roentgenograms of the abdomen. These studies should be carried out in both the recumbent and erect positions if possible. If the patient is too ill to stand or sit, the lateral decubitus may give valuable additional data. In the typical case of volvulus with obstruction, there may be demonstrable markedly distended loops of sigmoid which rise out of the pelvis into the mid-abdomen, the right upper quadrant, or to occupy the entire abdomen to the level of the diaphragm. If the volvulus has resulted in the formation of a closed loop, fluid levels may be visualized; if these levels are double, the diagnosis of volvulus may be established with a fair degree of certainty. It may in some instances be possible to demonstrate two points of obstruction in gas filled loops of bowel.

However, in our experience survey roentgenograms of the abdomen serve only to indicate that obstruction is present and that it is most probably in the lower portion of the colon, without making it possible to determine definitely the exact site or nature of the lesion. If more precise data are to be obtained, it is necessary to resort to the use of the barium enema. In our clinic, this is used in all cases unless the condition of the patient is so grave that it appears contraindicated. The opaque fluid is administered slowly with gravity pressure only, the container being suspended 18-24 inches above the table, and under constant roentgenoscopic control. We feel

that with these precautions carefully observed, the procedure is safe and provides invaluable data which are not obtainable in any other way and may be the means of saving the life of the patient. It must be constantly borne in mind that in some instances of volvulus, there is a valve type of obstruction which permits the enema fluid to enter relatively freely while expulsion cannot take place. Therefore, only small amounts are administered and the examination is terminated when the lesion has been demonstrated satisfactorily. If the volvulus has resulted in complete obstruction of the lumen of the colon, the opaque mixture will fill only the ampulla of the rectum and lower sigmoid. At this point, there will be observed a rounded or tapered point of stenosis which is smooth in outline and sharply defined. Not uncommonly, the obstruction to the barium enema is incomplete and small or moderate amounts of the injected fluid pass through the markedly narrowed points where the volvulus has occurred. Spiral bands of linear density alternating at irregular intervals with narrow bands of increased radiance over an area several centimeters in length in the sigmoid colon delineate the torsion of the colon. Spot roentgenograms with pressure under roentgenoscopic control usually demonstrate the corkscrew-like arrangement of the mucosa more satisfactorily than the routine roentgenograms. These findings are pathognomonic of volvulus and it is possible to establish a definite diagnosis on the basis of these changes. It is usually advisable to discontinue the examination at this point. However, the studies can be continued with caution and further filling of the colon may demonstrate the size of the involved loop, the presence of a second point of torsion in the proximal portion of the sigmoid, and the degree of rotation. These data may prove of value to the surgeon in planning the operative procedures to be used. After films have been exposed at various angles, the patient is permitted to expel as much as possible of the injected material and further observations are

made. These, also, should include roentgenoscopic studies, spot and routine roentgenograms with the Bucky diaphragm at various angles. The volvulus may in some instances be visualized more clearly at this time than when the colon was more completely filled with the opaque material (Fig. 2B). Double contrast studies may be helpful, but here particularly, caution is essential during the injection. We feel that this procedure is usually not necessary. Some observers have reported actually seeing the affected loops untwist during the roentgenoscopic studies, thus effecting a cure.

TREATMENT

Once the diagnosis of volvulus of the colon with obstruction is definitely established, surgery is indicated. Transfusion and other supportive measures are used as necessary prior to operation. The aim of the surgeon is to restore the normal position of the colon and correct or eliminate so far as possible any anomalies which might tend to result in recurrence. Resection and anastomosis, either in single or multiple stages, should be done if strangulation has occurred.

CASE REPORTS

CASE 1. F. W., male, white, single, aged ninety-seven. Patient entered the hospital because of swelling of the abdomen of three days' duration. He had been well until four years ago, when he developed severe constipation, which required mineral oil daily for relief. Three days ago, because of abdominal distress, he took a strong laxative. This was followed by a constant dull, gnawing pain in the left lower quadrant and distention. He passed large amounts of gas rectally, but there was no bowel evacuation for two days. On the day of admission, there was a small, watery movement. He had no fever or chills and had not lost any weight. He had severe nausea, but no vomiting. On examination, the patient was obviously extremely ill. The abdomen was markedly distended, with eversion of the umbilicus. There was no fluid wave. Marked tympany was elicited on percussion. The rectal examination was negative. The lungs were clear. Heart sounds were poor and irregular. The white count was 13,950; hemoglobin



FIG. 1. Case 1. *Volvulus of the sigmoid.* Barium enema studies showed normal filling of the rectum. There was partial obstruction in the region of the lower portion of the sigmoid with no apparent irregularity of outline. The volvulus is indicated by the arrow. The dilated loop of sigmoid is partially filled with the opaque mixture and contains much gas.

80 per cent; Hinton test negative. The urine contained no albumin; specific gravity 1.025, sugar 4+. A clinical diagnosis of probable cancer of the colon was made.

Roentgen studies on the first hospital day revealed marked distention of the colon with gas. On barium enema examination, there was complete obstruction in the region of the lower sigmoid. A cecostomy was performed. The colon was markedly distended with gas, cyanotic and edematous. The patient's condition was so poor that exploration was deemed inadvisable. There was no improvement after this operation. Two days later, the opaque enema studies were repeated. The rectum was dilated and filled normally. In the lower portion of the sigmoid, the lumen was markedly narrowed; there was no irregularity of outline. Small amounts of the opaque mixture passed through the area of stenosis and a volvulus of the sigmoid was dem-

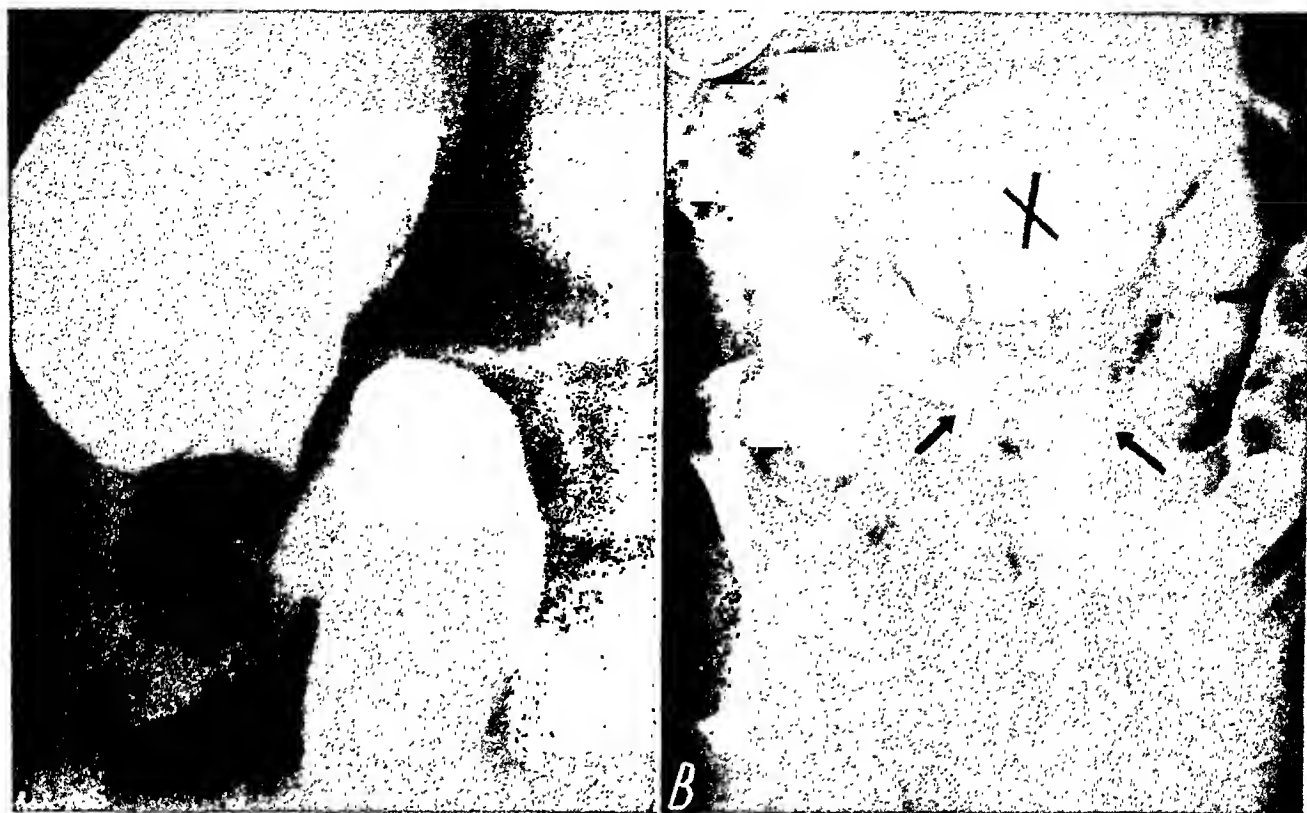


FIG. 2. Case II. *Volvulus of the sigmoid with partial obstruction*. *A*, the torsion of the colon is visualized clearly (arrow). The sigmoid is markedly dilated. *B*, after evacuation of the opaque enema. The dilated sigmoid is still partially filled with the opaque mixture. The two points of narrowing associated with the volvulus are indicated by the arrows. The obstruction was of the valve type, the sigmoid and descending colon retaining practically all of the opaque material which had been injected. The importance of the post-evacuation roentgenogram is well illustrated, as the points of torsion and the distention of the sigmoid are better seen than in *A* made during filling of the colon.



onstrated. The examination was thereupon discontinued. Operation performed later in the day revealed torsion of the sigmoid with one complete turn at the site indicated roentgenologically. The sigmoid was necrotic and fecal matter was present in the left lower portion of the abdominal cavity. Mickulicz resection was performed. The patient died twenty-four hours later.

CASE II. J. B., male, colored, married, aged sixty-six. The patient entered the hospital because of severe abdominal cramps and constipation; the symptoms had been present for three days. A compound cathartic pill taken the

FIG. 3. Case III. *Volvulus of the sigmoid with obstruction*. Roentgenogram of the abdomen showing a markedly distended loop of large bowel in the left side of the abdomen extending from slightly below the level of the iliac crest into the left upper quadrant.

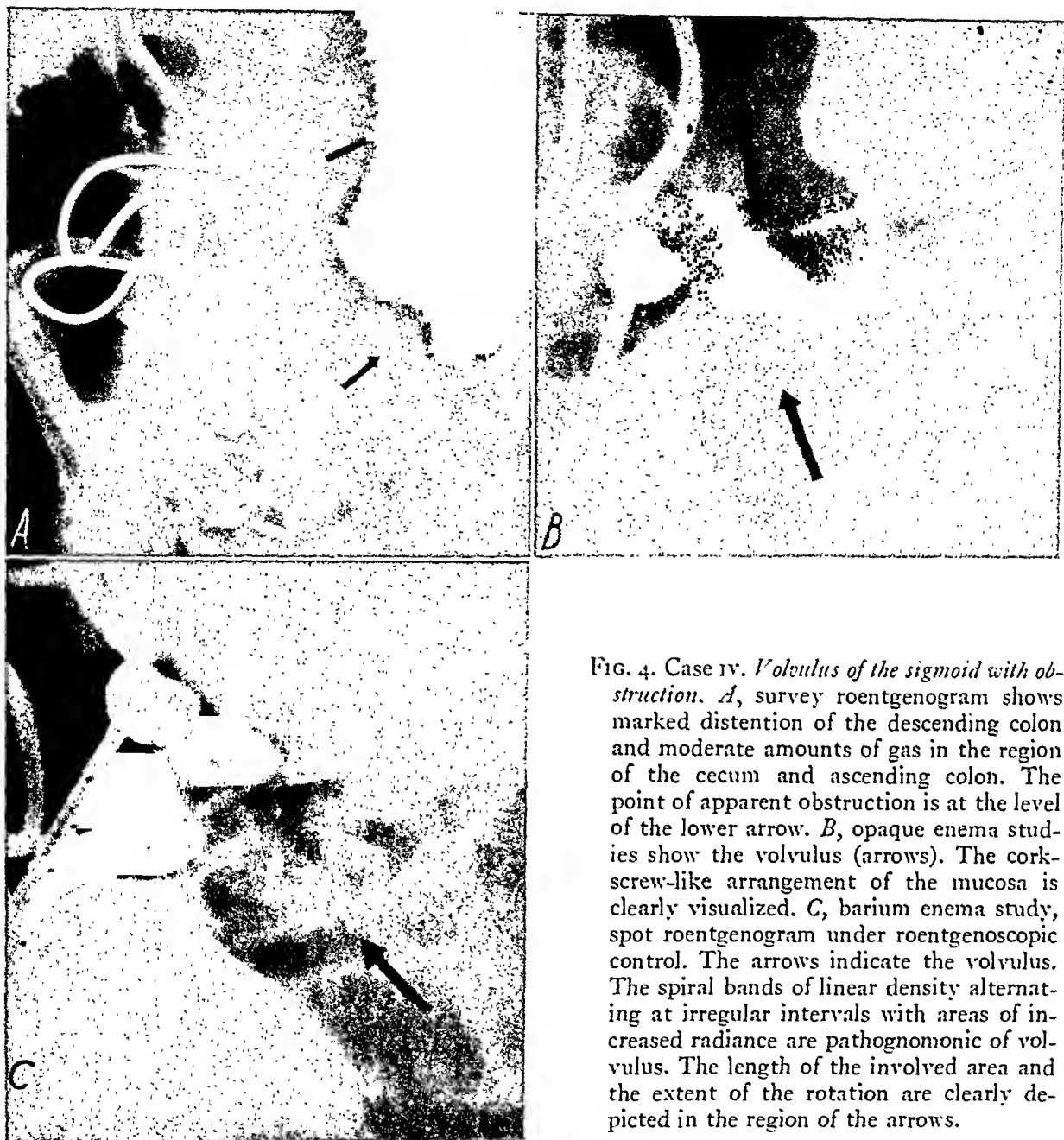


FIG. 4. Case IV. *Volvulus of the sigmoid with obstruction.* A, survey roentgenogram shows marked distention of the descending colon and moderate amounts of gas in the region of the cecum and ascending colon. The point of apparent obstruction is at the level of the lower arrow. B, opaque enema studies show the volvulus (arrows). The corkscrew-like arrangement of the mucosa is clearly visualized. C, barium enema study, spot roentgenogram under roentgenoscopic control. The arrows indicate the volvulus. The spiral bands of linear density alternating at irregular intervals with areas of increased radiance are pathognomonic of volvulus. The length of the involved area and the extent of the rotation are clearly depicted in the region of the arrows.

night before admission had increased the pain very markedly. He had never previously had constipation, bloody or tarry stools. On examination, the abdomen was moderately distended, tender and slightly spastic. Peristaltic sounds were increased in the left lower and upper quadrants, but were absent on the right. Survey roentgenograms of the abdomen revealed markedly distended loops of colon indicative of obstruction. Barium enema studies demonstrated a typical volvulus of the sigmoid and descending colon with a markedly distended loop of sigmoid between the two areas of torsion (Fig. 2, A and B). At operation performed later in the day, the volvulus was released and a Mickulicz

resection performed. The patient recovered and was discharged well.

CASE III. M. L., female, white, single, aged seventeen. She entered the hospital complaining of pain in the abdomen and obstipation of one week's duration. She stated that she had always been constipated. Her bowels moved only about once a week and the movements were always very large. There had never been bloody or tarry stools. Three days prior to admission she began to have pain in the lower abdomen. The pain was dull and inconstant at the onset, but had become very severe and was accompanied by fever and chilly sensations. She had been

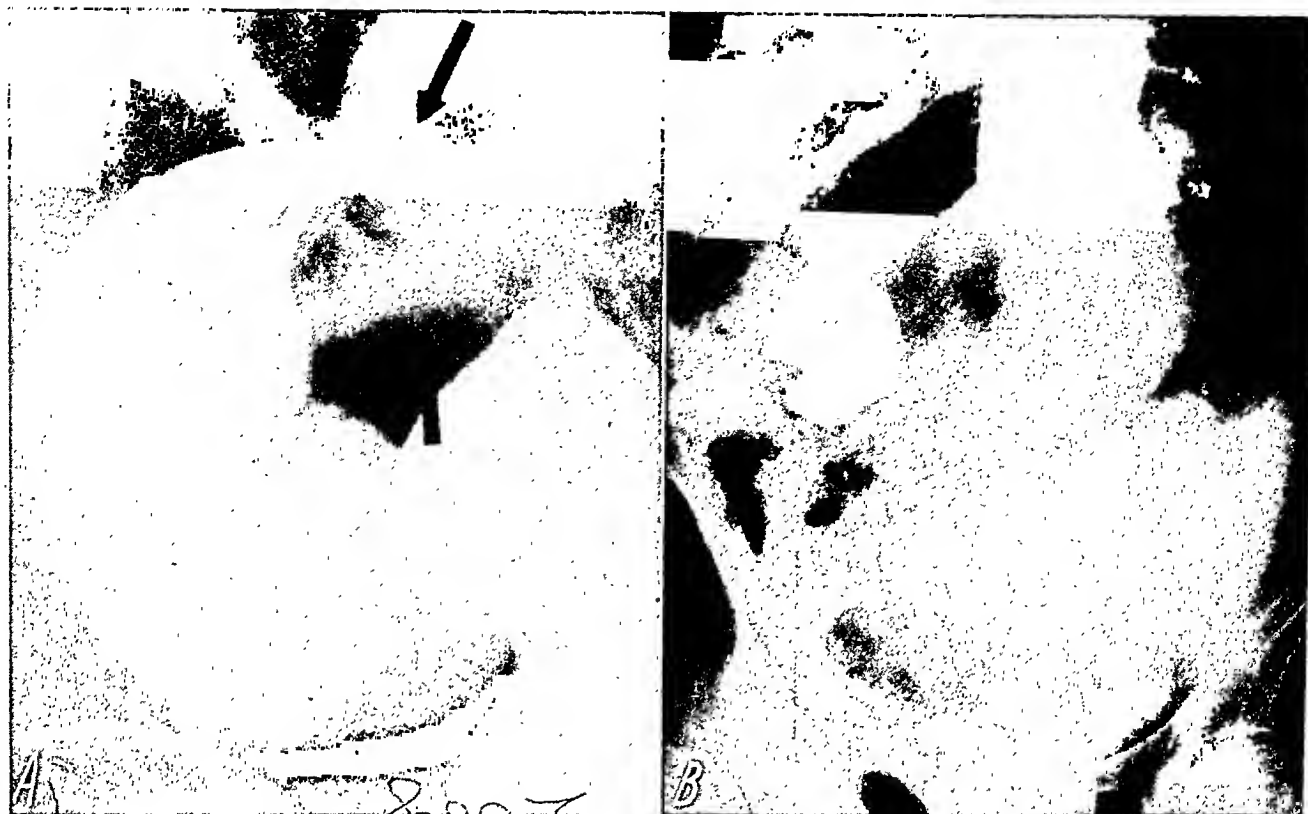


FIG. 5. Case v. *Volvulus of the sigmoid with obstruction*. A, barium enema study, spot roentgenogram made during roentgenoscopy. The involved area is indicated by arrows. The mucosal folds are arranged in spiral fashion. The sigmoid loop is markedly dilated. B, after evacuation of the opaque enema. The rectum is partially empty. The sigmoid loop is dilated and retains the opaque fluid. The proximal portions of the colon are markedly distended with gas.

nauseated and had vomited once. She had taken five cathartics and several enemas with no result. On examination, the abdomen was markedly distended and tympanitic. No masses were palpable. There was marked tenderness over the entire abdomen, more marked in the lower quadrants. Rectal and sigmoidoscopic examinations were negative.

The day following admission, roentgen studies of the abdomen revealed marked gaseous distention of the sigmoid and lower portion of the descending colon. A Miller-Abbot tube was passed and retained in position for three days without improvement of the patient's condition or relief of the distention. Prostigmine was ineffective. On the seventh hospital day, her condition became suddenly worse and immediate operation was deemed necessary. A 360°, clockwise rotation of the sigmoid was found. The loop was restored to normal position. There was localized gangrene of the sigmoid at the site of torsion and the colon proximal to the volvulus was markedly dilated, measuring about 5 inches in diameter. After resection of the gangrenous area, a colostomy was performed. About three

weeks later, because of retraction and partial closure of the opening, a transverse colostomy was done. This was subsequently closed and the descending colon anastomosed to the rectum. The patient was later discharged well.

CASE IV. G. D., male, white, married, aged sixty-one. Four years ago the patient was operated on for "bowel obstruction," a transverse colostomy being done for megacolon with fecal impaction. The colostomy was closed about five months later. He was always very markedly constipated and had been admitted to the hospital several times because of severe obstipation. The present attack began with pain in the lower abdomen and marked distention three days prior to admission. He had had no bowel movement for seven days. He vomited one day ago, a foamy white material with no food elements or blood. The pain was colicky in character and severe. On examination, the entire abdomen was markedly and symmetrically distended with generalized tenderness but no spasm or rigidity. The liver edge was not palpable and no masses could be felt. Tympany

was present and peristalsis was audible and high pitched. There was no fluid wave. Rectal examination was negative. The white count was 7,200; hemoglobin 78 per cent; non-protein nitrogen 34.

Roentgen studies shortly after admission comprised survey roentgenograms of the abdomen, which revealed marked gaseous distention of the ascending and descending portions of the colon, consistent with intestinal obstruction. A barium enema examination twenty-four hours later showed volvulus in the region of the sigmoid with a characteristic corkscrew arrangement of the mucosal folds. At operation, a Mickulicz resection of the lower colon was performed, an internal hernia and volvulus being found. The pathologic report was as follows: The wall of the gut shows edema and infiltration with inflammatory cells; there is an acute peritoneal reaction. He made a good recovery and the colostomy was closed about two months later.

CASE V. F. V., female, white, single, aged seventy-three. The patient entered the hospital because of abdominal distention. At the time of admission she was incoherent and irrational, so that no history was obtainable. A relative accompanying her was also unable to supply any details except that during the past week there had been complaint of abdominal pain apparently originating in the left lower quadrant with radiation to the right side and increase in the size of the abdomen. Physical examination was also unsatisfactory because the patient was drowsy and uncooperative. There was tympany over the entire abdomen and a suggestion of a mass in the left lower quadrant. The abdomen was markedly enlarged and tense. She appeared poorly nourished and dehydrated. The white blood count was 9,000. Non-protein nitrogen was 75, blood chlorides 72, and CO_2 , 49.

Roentgen studies of the colon revealed volvulus of the sigmoid with obstruction. Plasma was administered. The pulse became thready. Her condition was so poor that operation was deemed inadvisable. She became progressively worse and died eight days after admission to the hospital.

SUMMARY

Volvulus of the sigmoid is an important cause of intestinal obstruction. It is a con-

dition in which early diagnosis is essential as the mortality is high unless the condition is relieved promptly. The palliative measures applied in other forms of obstruction are ineffective in cases due to volvulus.

Clinical diagnosis is usually impossible.

Barium enema studies offer a method of localizing the obstruction and demonstrating its cause. The characteristic roentgen findings in volvulus are linear, curved densities alternating with bands of increased radiance over an area several centimeters in length in the sigmoid colon. This corkscrew-like arrangement of the mucosal folds is pathognomonic of volvulus.

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REFERENCES

1. ARAGO, C., and LEPPENNETIER, F. Volvulus du côlon pelvien. *J. de radiol. et d'électrol.*, 1939, 23, 314-316.
2. BACCAGLINI, M. Rilievi radiologici su di un caso di volvulo acuto del sigma. *Radiol. med.*, 1939, 26, 1031-1035.
3. BLOODGOOD, J. C. Intestinal obstruction due to volvulus or adhesions of sigmoid colon. *Ann. Surg.*, 1909, 49, 161-182.
4. BOCKUS, H. L., and others. *Gastro-Enterology*. W. B. Saunders Co., Philadelphia, 1944. Vol. II, p. 317.
5. BRAUN, W., and WORTMAN, W. *Der Darmverschluss*. J. Springer, Berlin, 1924.
6. CASE, J. T. Roentgenological aid in diagnosis of ileus. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1928, 19, 413-425.
7. FRIMANN-DAHL, J. Roentgen findings in intestinal knots. *Acta radiol.*, 1942, 23, 22-33.
8. FURBER, T. M. Chronic volvulus of sigmoid. *Med. J. Australia*, 1930, 2, 851.
9. GRIFFIN, W. D., BARTRON, G. R., and MEYER, K. A. Volvulus of sigmoid colon. *Surg., Gynec. & Obst.*, 1945, 81, 287-294.
10. GROTH, K. E. Axial torsion of colon through so-called physiological volvulus. *Acta radiol.*, 1934, 15, 153-168.
11. HALL, M. R. Roentgenological diagnosis of volvulus of sigmoid megacolon. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1938, 39, 925-927.
12. HINTON, D., and STEINER, C. A. Recurrent volvulus of sigmoid colon. *Ann. Surg.*, 1942, 116, 147-149.
13. HOLMGREN, B. S. Ein Fall von 360° Sigmoidumvolvulus ohne Strangulation und mit unbedeutenden Beschwerden. *Acta radiol.*, 1938,

- 19, 230-238. Also, Zwei interessante Fälle von Sigmoideumvolvulus. *Acta radiol.*, 1941, 22, 404-410.
14. HYMAN, A. Recurrent volvulus of sigmoid. *Am. J. Surg.*, 1928, 4, 443-444.
 15. JAMES, K. L. Volvulus of pelvic colon in young person. *Brit. M. J.*, 1938, 2, 569.
 16. LAURELL, H. Some cases of volvulus. *Acta radiol.* 1924, 3, 213. Also, Volvulus der Flexura sigmoidea. *Acta radiol.*, 1926, 7, 105-141.
 17. LEONARD, E. D., and DEROW, S. V. Volvulus; study of 22 cases. *New England J. Med.*, 1938, 218, 383-390.
 18. McIVER, M. A. Acute intestinal obstruction. *Arch. Surg.*, 1932, 25, 1106-1124; *Am. J. Surg.*, 1933, 19, 163; 365.
 19. METHENY, D., and NICHOLS, H. E. Volvulus of sigmoid. *Surg., Gynec. & Obst.*, 1943, 76, 239-246.
 20. PENDERGRASS, E. P. Role of roentgenologic examination in diagnosis of intestinal obstruction. *New England J. Med.*, 1941, 225, 637-641.
 21. PERLMANN, J. Klinische Beiträge zur Pathologie und chirurgischen Behandlung des Darmverschlusses. *Arch. f. klin. Chir.*, 1925, 137, 245-264.
 22. PERTHES, G. Die Behandlung des akuten mechanischen Darmverschlusses. *Arch. f. klin. Chir.*, 1905, 76, 943.
 23. PROBSTEIN, J. G., and SENTURIA, H. R. Volvulus of sigmoid colon; discussion of combined volvulus and hepatodiaphragmatic interposition. *Surg., Gynec. & Obst.*, 1943, 77, 669-672.
 24. RIGLER, L. G., and LIPSCHULTZ, O. Roentgenologic findings in acute obstruction of the colon, with particular reference to acute volvulus of sigmoid. *Radiology*, 1940, 35, 534-543.
 25. SANTE, L. R. Intestinal obstruction. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1935, 34, 744-754.
 26. SWEET, R. H. Volvulus of cecum; acute and chronic with reports of 8 cases. *New England J. Med.*, 1935, 213, 287-293.
 27. TREVES, F. Intestinal Obstruction. William Wood & Co., New York, 1899.
 28. WEEKS, C. Volvulus of sigmoid megacolon. *Ann. Surg.*, 1931, 94, 1050-1060.



ROENTGEN DIAGNOSIS OF DISEASES OF THE NECK OF THE BLADDER*†

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ALTHOUGH the urinary disturbances that make up the bladder neck syndrome (*Oeconomos*) are more frequent in the male climacteric and preclimacteric, they are also seen in infancy and adolescence.

In adulthood their presence indicates one of two frequent conditions: adenoma or cancer of the prostate.

In infancy and adolescence they always presuppose the existence of congenital anomalies of the prostatic portion of the urethra. If these are excluded, diseases of the neck of the bladder are considered and careful examinations made to determine the anatomical cause responsible and to permit of effective treatment.

For a long time the routine examinations (rectal palpation, sounding and cystoscopy) gave very little information on this subject but on the introduction of cysto-urethroscopy (cystoscopy by the McCarthy method) a great deal was accomplished in the diagnosis not only of those conditions which Legueu called dysfunctions of the neck and Marion disturbances of the neck, but also of the congenital anomalies and acquired defects to which the bladder neck is subject, though rarely.

Heitz-Boyer was the first to include urethrography in the methods of examination of these conditions, with the result that this and cysto-urethroscopy brought about great changes in this new field of urology.

In his writing on the subject in 1933 he does not discuss the roentgenological method nor describe the characteristics of the various types of disease.

Marion, discussant of the subject "Disturbances of the Neck of the Bladder" be-

fore the Fifth Congress of the International Society of Urology which met in London in 1933, restricted diagnosis to the investigation of the symptomatology and the routine methods of examination, from which he excluded cystoscopy.

Colombino also at the same Congress, referring to the question of diagnosis, considered only the cysto-urethroscopic appearance of certain types of disease of the neck.

Rubritius of Vienna, who devoted a great deal of attention to this subject, emphasizes rectal palpation, the manner of micturition, sounding and cystoscopy as methods of diagnosis, and cystometry (bladder manometry) for the purpose of investigating the function of the detrusor in the course of development of certain diseases.

Chwalla described four typical cystoscopies and in our country Meira discussed these, but did not refer to examination by urethrography.

None of the most authoritative authors on the subject, however, assign greater value to urethrography or urethro-cystography in the diagnosis of any of the conditions that cause the diseases of the neck.

The cysto-urethrographic examinations made since 1936 in our patients with the bladder neck syndrome and described in our works "The propedeutic value of urethro-cystography" published in the *Review of the Paulista Medical Association* in November, 1936, and "Contribution to the roentgen diagnosis of affections of the neck of the bladder," a preliminary note presented before the Section of Urology of the Paulista Medical Association August 25,

* Translation made by Audrey G. Morgan, M.D., Medford, Oregon.

† Read before the Section on Radiology of the Paulista Medical Association, January 22, 1944.

1940, show the undeniable value of such examinations, not only in the individualized diagnosis of the clinical forms of adenoma of the prostate, but also of the conditions which constitute the true affections of the bladder neck (congenital anomalies and acquired deformities) and those which most frequently cause the so-called diseases of the neck of the bladder.

Most authors do not give a clear description of each anatomical condition responsible for the dysfunctions of the bladder neck; there is even a certain confusion in considering some of them, such as hypertonia and sclerosis, fibrosis and hypertrophy of the trigonal muscle.

But clinical, cysto-urethoscopic and cysto-urethrographic examinations, transvesical surgical inspection of the neck and histopathological examinations furnish means of differentiating the following anatomical conditions which cause the so-called diseases of the bladder neck and their well known syndrome.

A. *Valves of the Neck* (valvula coli), resulting from an atrophy or congenital hypoplasia of the prostate gland and which are differentiated into:

1. (a) Valves without gland substance
Formed only by mucosa (mucous valves)
Formed of mucosa and muscle (muscular valves)
- (b) Valves with gland substance (musculoglandular valves).
2. Great development of the circular bundles but without a projecting border which acts as a valve (Englisch).

B. *Congenital atrophy of the neck* which is based on absence or congenital hypoplasia of the prostate. The internal opening of the urethra is punctate and the prostatic part of the urethra short and not very well developed, or very much elongated. Sometimes the colliculus seminalis is hypertrophied (Athayde Pereira).

C. *Acquired atrophy of the neck* resulting from:

- (a) senile atrophy of the prostate

- (b) absence of the prostate from extirpation
- (c) atrophy of the prostate from castration or disease of the testicles
- (d) atrophy from suppuration of the prostate
- (e) traumatic atrophy of the prostate.

In these conditions the bladder neck (internal opening of the urethra and sphincter of the bladder) is involved in the pathological process and loses its normal characteristics.

D. *Sclerosis of the neck* based on inflammatory atrophy (contraction) of the prostate (chronic disease) and the forms of chronic prostatitis with fibrosis and retraction (v. Lichtenberg-Heckenbach).

This is a transformation of the contractile element of the sphincter of the neck into cicatricial tissue resulting from acute or chronic inflammation (inflammatory and cicatricial atrophy).

There is loss of contractility, excess of connective tissue and atrophy of the submucosa to the degree to which the mucosa becomes cicatrized.

The names which some authors have given this condition of cicatricial sclerosis and inflammatory fibrosis of the neck result from this.

This appearance may be found also in cancer of the prostate (scirrhous).

Here we must consider:

- (a) Genuine sclerosis (sclerosis of the internal opening of the urethra), sclerosis of the sphincter (inflammatory) and the sclerosis of senile involution.
- (b) The glandular sclerosis (pseudosclerosis) of adenoma without hypertrophy (adenoma of the prostatic glands properly speaking and rarely "very minute intraprostatic adenomata").
- (c) Sclerosis following prostatectomy (permanent tampon); endoscopic resection and electrocoagulation of the neck.

E. *Hypertonia of the sphincter of the*

neck (rigidity of the sphincter—Chwalla, contracture of the neck of the bladder—Chetwood) which may be transitory or permanent, and which may bring about functional hypertrophy of the sphincter (hypertrophic ring of the internal opening of the urethra—Englisch).

The substrate of hypertonia may be:

- (a) Inclusions of micro-adenomata in the sphincter which irritate it and provoke contracture.
- (b) Defective innervation of the sphincter.
- (c) Existence of subacute or chronic inflammation of neighboring organs (prostate and seminal vesicles).

Rubritius includes also:

- (1) Idiopathic hypertonia of rather obscure etiology to which many authors attribute a congenital origin and find it only in young people.
- (2) Hypertonia of central origin (transitory or permanent) in the beginning of tabes, in myelitis, multiple sclerosis, trauma of the medulla and the myelodysplasia of spina bifida occulta.

In the syndrome caused by the latter, tenesmus supplants the other symptoms.

F. Hypertrophy of the trigonal muscle. This has been studied thoroughly by Young, Hinmann and Wesson, under the name, however, of fibrosis of the neck, but distinct from inflammatory fibrosis.

Rarely it originates in congenital defect but in the majority of cases it is acquired. The compensatory hypertrophy is the result of the muscular force required for the constant opening of the bladder orifice (internal opening of the urethra) obstructed for a shorter or a longer period or permanently, by some obstacle to the passage of the urine.

It is also called "median bar" and is frequently accompanied by hypertrophy of the interureteric ligament (interureteric torus, Mercier's bar).

Fasciculated bladder and pulsion diverticula are the effects on the detrusor, while the urinary syndrome (dysuria, pol-

lakiuria and retention) results from dysfunction of the sphincter and the condition of the detrusor.

Hypertrophy of the trigonal muscle is a compensatory condition which may disappear with removal of the obstacle (calculus of the prostatic urethra, stricture of the urethra, adenoma of the median lobe and sclerosis of the neck itself).

Hypertrophy of the trigone after a time becomes an obstacle to micturition, resulting in a serious exacerbation of the above mentioned neck syndrome (dysuria, pollakiuria, tenesmus of the bladder and the neck and retention of urine).

This hypertrophy finally becomes transformed into a valve with a posterior recess by the dorsal elevation of the muscular part of the trigone, including the interureteric ligament.

The more urine accumulates in the bladder, the more impossible its physiological evacuation becomes.

For the roentgen diagnosis of these conditions it is necessary to prepare the patient with a thorough irrigation of the rectum.

The presence of fecal masses or gas in the ampula interferes with the examination by superimposing spots on the image of the bladder neck, which is to be studied particularly.

The technique used by us* is based on:

(a) The previous filling of the bladder for the purpose of demonstrating its whole internal outline, particularly that of the basal portion. Sixty to 80 cc. of contrast medium is injected. When there is residual urine the emptying of the bladder by sounding should precede the filling with contrast medium.

(b) The filling of the whole length of the urethra with 15 to 20 cc. of contrast medium. A syringe holding 20 cc. is used for this purpose, the piston of which should slide easily and to which is attached a rub-

* Pereira, A. Contribution to the roentgen diagnosis of affections of the bladder neck; preliminary note. Urological Section of the Paulist Medical Association, August 25, 1940.

ber tip capable of closing the meatus of the urethra.

(c) A roentgenogram made exactly at the termination of the filling of the urethra.† This makes it possible to obtain a clear view of the prostatic urethra and a perfect image of the internal opening of the urethra with the changes which will identify the various types of dysfunction and other diseases. The injection should not be too rapid nor yet too slow. Care must be taken not to use violence so as not to impair the clearness of the roentgen image and not to cause rupture of the bulb with arteriovenous reflux.

Positions. From the point of view of systematizing the examination two positions are used: (a) oblique or semiprofile (in which the image of the prostatic urethra is detached from that of the symphysis pubis); (b) anteroposterior, or from in front. In the first the patient is placed in dorso-lateral decubitus, preferably right, with the hip flexed and in forced abduction, while the opposite leg is extended, holding the foot of the flexed leg. In the anteroposterior position the patient lies in dorsal decubitus.

Centering the roentgen tube on the pubis the roentgenogram is made according to the special requirements of each apparatus (milliamperage, exposure time and kilovoltage, which vary with the thickness of the patient's body).

In the anteroposterior position better images are obtained with an axial incidence of the rays on the pelvis (Sgalitzer's method).

Though there is a great deal of discussion in regard to the qualities and the preference to be given to the various contrast media used in the examinations (thorotrast, uroselectan and perabrodil, 20 per cent lipiodol or neoiopodin, 15 per cent sodium iodid, 30 per cent suspension of neobaryta, barium sulfate and citobarium, some of them dangerous, others irritating, some expensive) we prefer a

suspension of luxbarium,* made by the Spic Laboratory of São Paulo, because of its low cost, ease of preparation, chemical harmlessness and perfect tolerance.

The suspension is prepared at the time of using by adding 30 gm. of the powder to 100 cc. of boiling water in a vessel previously heated.

Roentgen Diagnosis. Having obtained the two roentgenograms, profile and anteroposterior, the interpretation or roentgen diagnosis must then be made. It is the urologist who is best fitted to make this examination and interpret it most accurately. He knows the clinical history of the patient, has made the necessary examinations and knows what is to be proved or disproved.

With regard to the diagnosis of diseases of the bladder neck the following will have to be considered: (a) the filling characteristics of the bulbar, membranous and prostatic urethra; (b) the shortening, lengthening, deformities, dilatations and angulations of the prostatic urethra (supra- and inframontanal parts); (c) the appearance of the internal opening of the urethra, its position in relation to the bladder cavity, its borders; (d) the configuration of the elevations of the basal plane of the bladder, and (e) the completeness, clearness and deformities of the internal outline of the bladder (Fig. 1, 2, 3, 4 and 5).

The roentgen diagnosis will result from the detailed observation of the points mentioned above, taking into consideration the characteristics of the prostatic urethra, of the internal opening of the urethra of the basal plane and the outline of the cystogram. The roentgenogram not only furnishes elements for the diagnosis of diseases and their effects on the bladder (detrusor), but if these are lacking it gives evidence of the plastic tonus, hypertonia, paresis or complete atony of the bladder.

Nevertheless the interpretation will be arrived at by a careful inspection of the combined results of cystography and urethrography which will be completed by the

† Based on the principle of cerebral arteriography of Egas Moniz of Lisbon.

* Base barium sulfate.



FIG. 1, 2, 3, 4 and 5. Normal bladder neck.

FIG. 1. E. M., aged forty-four. Relative impotence. Profile roentgenogram.

clinical history of the patient and sometimes by other routine examinations (palpation, sounding, cysto-urethroscopy).

In diseases of the neck it is only possible to fix roentgenologically three images which correspond to anatomical conditions:

1. *Image of the plane neck* (Fig. 6 to 13) without protruding borders in both the pro-



FIG. 2. J. P., aged forty. Varicocele, relative impotence. Profile roentgenogram.



FIG. 3. M. M., aged forty-four. Latent prostatitis and exaggerated dilatation of the prostate gland. Profile roentgenogram.

file and anteroposterior roentgenograms. It represents a hypoplasia of the sphincter and of the tissues which form the borders at the internal opening of the urethra, or a retraction from sclerosis both of these tissues and of the sphincter itself. It corresponds to both congenital and acquired atrophy and to sclerosis of the neck.

The differentiation between them can only be made by clinical examination in association with some roentgen characteristics of the prostatic urethra.



FIG. 4. E. A., aged fifty-six. Relative impotence, latent adnexitis. Profile roentgenogram.

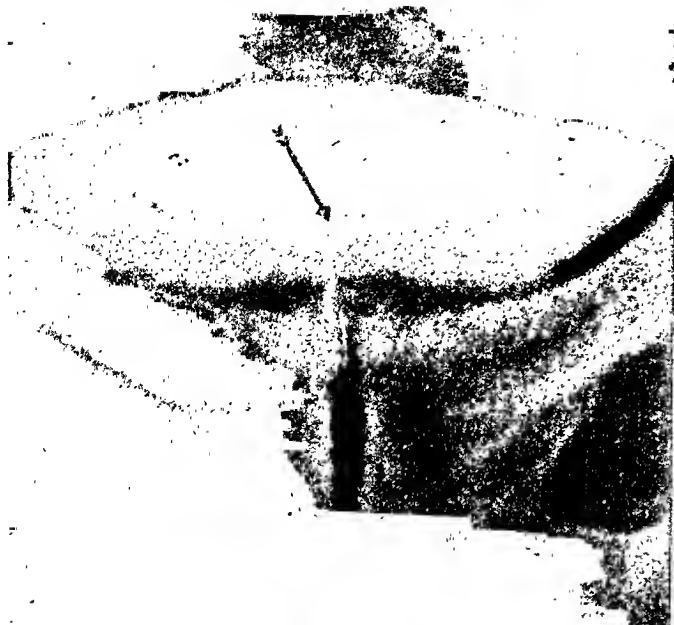


FIG. 5. C. G., aged forty. Relative impotence, hypertrophy of the colliculus. Anteroposterior roentgenogram.

(a) In congenital atrophy the prostatic urethra is short, or slender and much elongated. Sometimes the colliculus seminalis is hypertrophied.

(b) In acquired atrophy the internal opening of the urethra is changed, but the prostatic urethra may keep its propor-

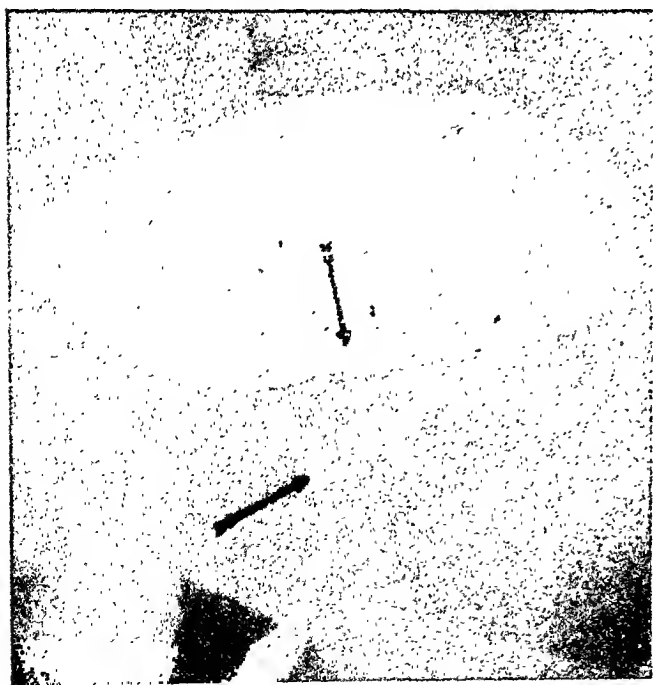


FIG. 6. E. C., aged forty. Plane neck. Congenital hypoplasia of the neck and prostate. Profile roentgenogram.



FIG. 7. B. S., aged forty. Plane neck. Congenital hypoplasia of the neck and prostate. Hypertrophy of the colliculus. Profile roentgenogram.

tionate dimensions (coagulation of the neck, partial or total resection).

In the atrophy of senile involution with reduction of the size of the prostate, obviously the prostatic urethra is shortened.

(c) In sclerosis of the bladder neck,



FIG. 8. E. R., aged thirty-eight. Plane neck. Congenital hypoplasia of the neck and prostate. Profile roentgenogram.



FIG. 9. N. R., aged twenty-nine. Plane neck. Congenital hypoplasia of the neck and prostate. Hypertrophy of the colliculus. Profile roentgenogram.

shortening generally occurs because of the inflammatory retraction of the prostate gland.

The image is identical in the profile and anteroposterior roentgenograms. It shows a punctate smooth neck in the fundus of the bladder which does not change under anesthesia (operative verification).



FIG. 10. The same case as in Figure 9. Anteroposterior roentgenogram.



FIG. 11. V. S., aged thirty-six. Plane neck. Inflammatory atrophy of the neck and prostate. Stricture of the urethra. Profile roentgenogram.

2. *Fish-mouth image* (Fig. 14 to 18). This represents exaggerated growth of the borders into the bladder cavity and corresponds to an exaggerated tonus of the sphincter. The image corresponds also to what is seen in the neck when the bladder is opened. But under local anesthesia more than under spinal or general anesthesia, the sphincter relaxes and the protrusion disappears. It is therefore a transitory image and exists only when there are attacks of hypertonia of the sphincter.

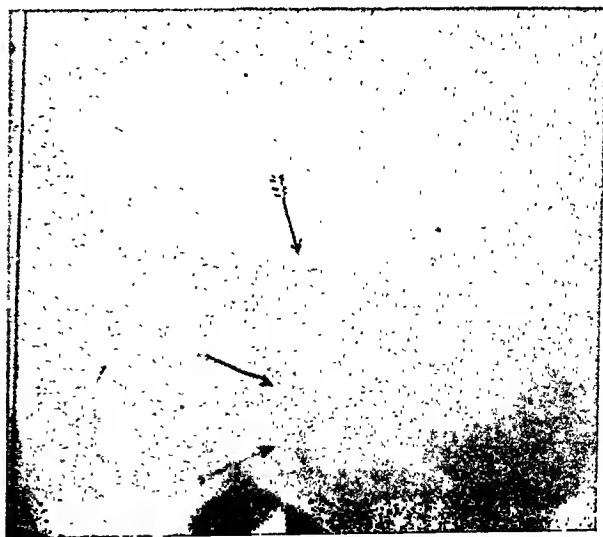


FIG. 12. E. B., aged sixty-eight. Plane neck. Atrophic prostate, sclerosis of the neck, hypertrophy of the colliculus. Profile roentgenogram.



FIG. 13. M. S., aged fifty. Plane neck. Atrophic prostate, sclerosis of the neck, urinary infection. Profile roentgenogram.

In certain diseases of the medulla the hypertonia becomes permanent and in that case the image persists and is not changed by any kind of anesthesia.

It is reproduced better in the profile than in the anteroposterior roentgenogram and always shows an elongation of the image of the prostatic urethra.

3. *Image of hypertrophy of the trigonal muscle* (Fig. 19 and 20). Here the tissue which corresponds to the trigonal muscle

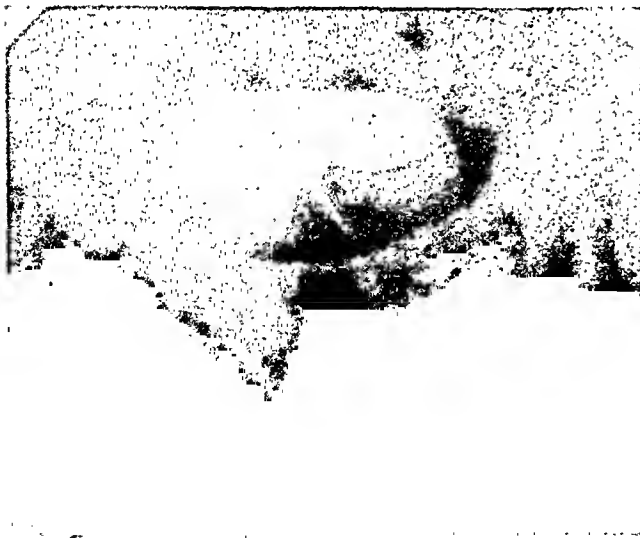


FIG. 14. B. M., aged sixty-four. Hypertonia of the sphincter, subacute prostatovesiculitis. Profile roentgenogram.

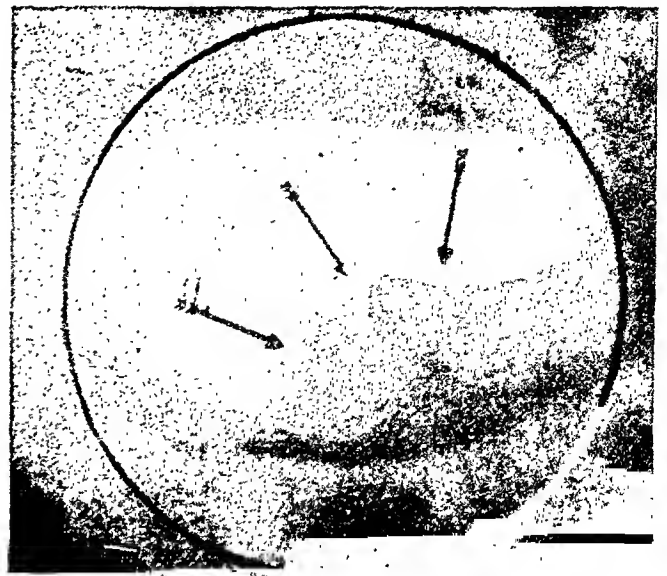


FIG. 15. The same case as in Figure 14. Enlarged image.

(seen in profile) is increased and tends to invade the bladder. In this growth it extends along the prostatic urethra and deviates the internal opening of the urethra so that it projects forward. As it is a progressive condition, in the early stages the prostatic urethra is not changed and the muscle protrusion is barely perceptible.

The roentgen image faithfully reproduces these appearances but only in the profile roentgenogram. The posterior border of the internal opening of the urethra grows forward and becomes superimposed on the

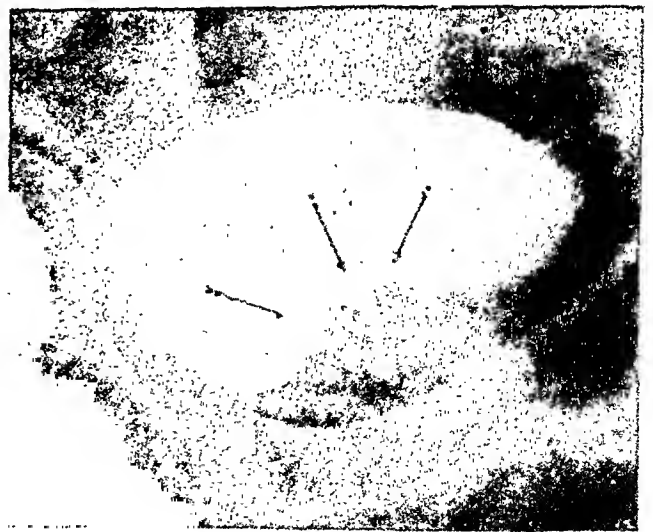


FIG. 16. M. M., aged twenty-eight. Hypertonia of the sphincter, subacute prostatovesiculitis. Profile roentgenogram.



FIG. 17. A. F., aged forty-seven. Hypertonia of the sphincter, subacute prostatovesiculitis. Profile roentgenogram.

anterior border, even forming a sort of valvular tongue.

In the anteroposterior roentgenogram taken in the advanced stages the image may resemble that of adenoma of the median lobe in the beginning of its growth.

When the hypertrophy of the median lobe coincides with hypertrophy of the trigonal muscle the image does not show anything characteristic except the protrusion of the adenoma itself.

Among 20 cases of disease of the bladder

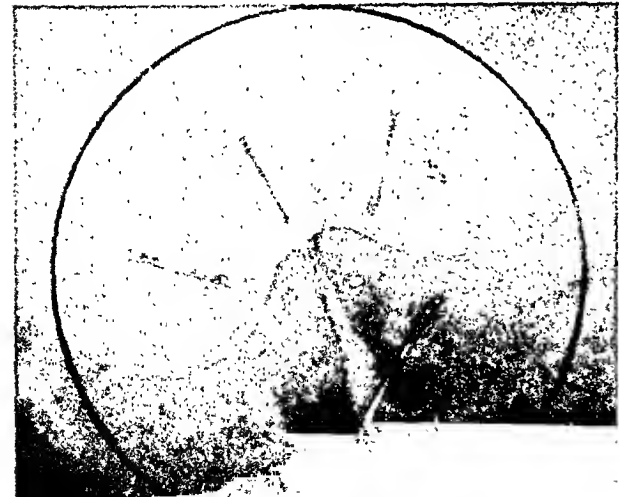


FIG. 18. J. A., aged fifty-eight. Hypertonia of the sphincter with a subacute exacerbation. Profile roentgenogram; image enlarged.

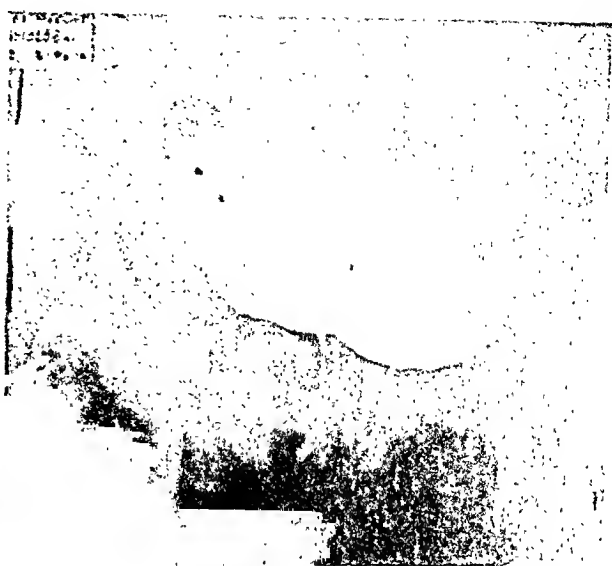


FIG. 19. J. M., aged fifty-eight. Hypertrophy of the trigonal muscle, stricture of the urethra, prostatovesiculitis. Profile roentgenogram.

neck examined the following roentgen forms were seen:

	Cases
Congenital atrophy of the neck.....	4
Acquired atrophy.....	1 (trauma)
Sclerosis of the neck.....	6
Hypertrophy of the sphincter.....	6
Hypertrophy of the trigonal muscle...	3

In 4 cases surgical operations to which the patients were subjected showed that the roentgen images corresponded exactly to the surgical findings (plane neck with punc-

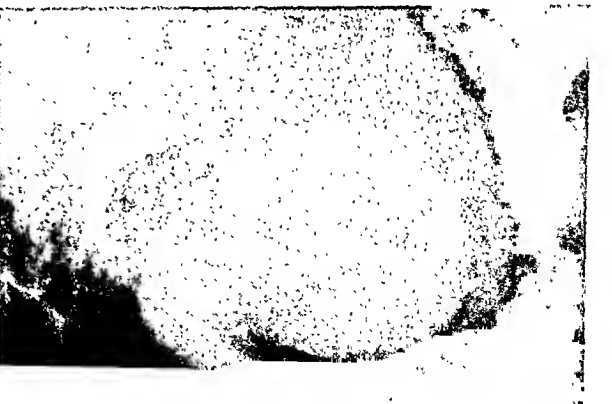


FIG. 20. P. S., aged sixty-one. Hypertrophy of the trigonal muscle, total stricture of the urethra, urinary infection, tabes. Profile roentgenogram.

tate orifice, protrusion of the mucosa of the neck into the bladder and valvular protrusion of the posterior border of the neck).

In a case of hypertrophy of the trigonal muscle operated on by Blatt's technique (cuneiform resection) the characteristic histopathology of the excised segment was found (muscular hypertrophy and interstitial fibrosis).

A cystogram obtained in conjunction with urethrography in some cases showed disease of the detrusor, such as hypertrophy (fasciculated bladder), pulsion diverticula and the image of parietic bladder (the detrusor does not accommodate itself by plastic tonus to the contrast medium injected into the bladder and the image loses its clearness of outline, particularly in the free parts of the bladder).

Accidents during Urethrocystography. Although these examinations are carried out by specialists accidents do occur to which attention should be called: (a) small inflections of the mucosa of the prostatic urethra from distention during filling; (b) fissuring of the bulbar cul-de-sac from distention if the injection of contrast medium is continued when there is spasm of the striated sphincter; (c) even rupture of the bulbar cul-de-sac with urethrovenous reflux or extravasation of the injected contrast medium; (d) reactivation of latent inflammatory processes in the prostate and seminal vesicles as well as recurrences of pre-existing pyelonephritis.

Contraindications. In the roentgen diagnosis of diseases of the neck of the bladder there are contraindications to cystourethrographic examination which may be summarized as follows: (a) when there is recent trauma resulting from instrumental examination with or without loss of blood (danger of reflux and its serious consequences); (b) in patients with acute or recent gonorrhea; (c) in the course of acute adnexitis (recurrent prostatovesiculitis) with attacks of hypertonia; (d) in acute attacks of cystitis; (e) in the course of regression of abscess of the prostate opening into the urethra.

CONCLUSIONS

From a number of patients examined in whom the diagnosis of disease of the neck of the bladder could be made by roentgenography, we conclude that urethrocystography as practiced by us is necessary and even indispensable in the examination of these patients:

(a) Because it permits of an accurate differentiation between the different anatomical conditions and anomalies of the neck responsible for disease.

(b) Because it permits of differential diagnosis from adenoma of the prostate, particularly that of the median lobe.

(c) Because it makes it possible to determine the condition of the detrusor during disease, showing its hypertrophy, pulsion diverticula and the sign of parietic bladder.

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REFERENCES

1. BLUM and RUBRITUS. Handbuch der Urology. Vol. V. 1938.
2. BLATT, P. Die Sphinkterkeilexcision bei den Erkrankungen des Blasenhalsses (Sphinkterhypertonien und Sphinktersklerosen). *Ztschr. f. urol. Chir. u. Gynäk.*, 1936, 42, 31-47.
3. BOUILLIÉ, M. L'hypertrophie du col vésical. *J. d'urolog.*, 1929, 27, 97-142.
4. BLUM. Ueber Behandlung der Blasenhalsskontraktur mittels Electrokoagulation. *Ztschr. f. Urol.*, 1929. *Verhandl. d. deutsch. Gesellsch. f. Urol.* VIII Kong., 1921.
5. CHETWOOD. Prostatism without enlargement of the prostate. *Ann. Surg.*, 1905, p. 497.
6. CHOLZOFF. Konstriktur des Blasenhalsses. *Folia urolog.*, 1910, 4.
7. EISENDRATH, D. N., and ROLNICK, H. C. Urology. Fourth edition. J. B. Lippincott Co., Philadelphia, 1938.
8. HINTCHACK, TH. Ueber endoscopische Sphinkterereinkerbung bei der Blasenhalsskontraktur. *Ztschr. f. Urol.*, 1929. *Verhandl. d. deutsch. Gesellsch. f. Urol.* VIII Kong., 1921.
9. JANKE, H. Erfahrungen mit der operativen Behandlung der Sphinkterhypertrophie. *Ztschr. f. Urol.*, 1929. *Verhandl. d. deutsch. Gesellsch. f. Urol.* VIII Kong., 1921.
10. LEWIN, A., and TATERKA, H. Die Veränderungen der Harnwege bei Erkrankungen des Centralnervensystems (Tabes, multiple Sklerose).

- Ztschr. f. Urol.*, 1929. *Verhandl. d. deutsch. Gesellsch. f. Urol.* VIII Kong., 1921.
11. LOWSLEY, O. S., and KIRWIN, T. J. *Clinical Urology*. Vol. II. Williams & Wilkins, Baltimore, 1940.
 12. MARION, G. Maladie du col vésical. *J. d'urol.*, 1933, 36, 513; 1934, 37, 5.
 13. MARION, G., and WEIJTLANDT. V Cong. de la Soc. Internat. d'Urol., London, *J. d'urol.*, 1933, 36, 565.
 14. MEIRA, M. Pathologia do cólo vesical. Calvino Filho, Rio.
 15. NICOLICH, C. Vier Fälle von Harnverhaltung durch entzündliche Veränderungen des Blasenhalbes bedingt. *Ztschr. f. Urol.*, 1929. *Verhandl. d. deutsch. Gesellsch. f. Urol.* VIII Kong., 1921.
 16. PEREIRA, A. Contribuicao ao diagnostico radiologico das afecoes do colo vesical; nota previa. Sec. de urol. d. ass. paulista de med., Aug. 25, 1940.
 17. PRETORIUS, G. Zur pathologie des pars prostatica und des Prostata. *Ztschr. f. Urol.*, 1923, 1-2.
 18. RANDALL. Prostatism sans prostata. *New York Med. J.*, 1915.
 19. RUBRITIUS, H. Durch dauernden Sphincterkrampf bedingte Retencionen und ihre Behandlung. *Verhandl. d. deutsch. Gesellsch. f. Urol.* VIII Kong., 1921.
 20. RUBRITIUS, H. Zur Frage der idiopathischen Sphincterhypertonie. *Ztschr. f. Urol.*, 1923.
 21. RUBRITIUS, H. Die Hypertonie des inneren Blasensphinkters. G. Thieme, Leipzig, 1938.
 22. TRACZYK, S. Les prostatiques sans prostate. *J. d'urol.*, 1933, 36, 544-550.
 23. YOUNG and WESSON. Anatomy and surgery of trigon. *Ann. Surg.*, 1921.



HOW EXACT IS THE ROENTGEN DIAGNOSIS OF HEART VALVE CALCIFICATIONS?

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EXCEPT for statements of Sosman no publications concerning the exactness of the roentgen diagnosis of heart valve calcifications seem to exist. Sosman reports the diagnostic results in 20 patients, where calcifications were demonstrated roentgenologically; in every case massive calcium deposits were found at autopsy. There was one diagnostic error in interpretation, a deposit of calcium in the aortic valve be-

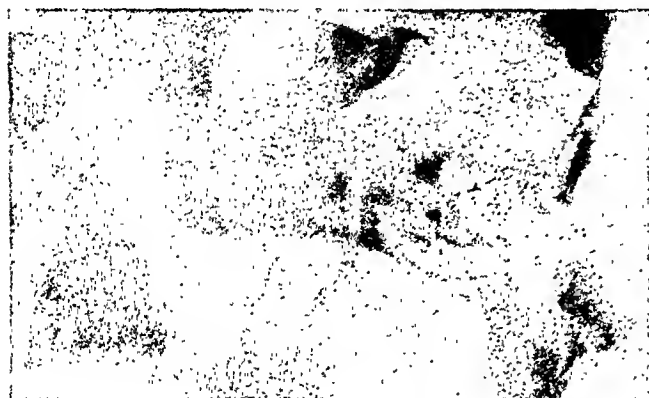


FIG. 1. Autopsy specimen (roentgenogram). Four small calcareous deposits in the mitral valve; the largest of these was diagnosed while the patient was still living.

ing interpreted as calcification in the coronary arteries. This was a positive error of 5 per cent. The negative error was much greater, as often cases of chronic valvular disease were seen with small or moderate-sized calcium deposits in the injured valves which had been overlooked or missed at roentgenoscopy. Recently Sosman has stated that the positive roentgen findings were now confirmed at autopsy in every case; no records as to the actual extent of error in the negative roentgen diagnosis are found in this article.

We have been able to control our positive or negative roentgen findings in 33 patients. This material* includes only cases with autopsy-verified alterations of the

valves, which are calcareous in 11 and non-calcareous in 22 cases. The alterations are due either to endocarditis or to syphilis. Cases with atherosclerotic affections of the valves are not included in this material; neither are cases with intact valves in non-valvular heart disease. Our results were the following: from 8 cases of calcification in the mitral valve 6 were found and 2 were missed at roentgenoscopy, 2 cases of calcification in the aortic valve were both found, and 1 further case of calcification in both the mitral and the aortic valve was missed at roentgenoscopy. In one of the diagnosed cases the calcareous deposit seen during life was found to be only 1.5×2 mm. at autopsy (Fig. 1). In cases with non-calcareous alterations the roentgenological record always has been negative. Thus we had our positive roentgen findings confirmed at autopsy in every case, while the error of the negative diagnosis was 12 per cent. We usually used 90 kv. (peak) and 3 ma. in chest roentgenoscopy.

Errors in the roentgen diagnosis may be caused by the method (massive pleural effusions, which make it difficult to see details; corpulent patients). Most of the errors, however, are caused by the roentgenologist himself, e.g. if he is tired, if he has not adapted his eyes adequately, or if for some cause he cannot work with full attention. Once, after night service in the medical department, I in spite of all care missed a mitral calcification; a few days later I diagnosed it in the same patient at a glance. I have looked for the dates when the errors happened; in 2 of our 3 overlooked or missed cases the roentgenologist probably found it difficult to concentrate.

The purpose of this publication is to show the actual extent of error in the negative roentgen diagnosis of heart valve calcifications, and also to confirm the state-

* Collected at the I. Medical Clinic of the University Tartu.

ments of Sosman as to the accuracy of the method.

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REFERENCE

1. SOSMAN, M. C. Technique for locating and identifying pericardial and intracardiac calcifications. AM. J. ROENTGENOL. & RADIUM THERAPY, 1943, 50, 461-468 (bibl.).



THE EFFECTS OF BETA IRRADIATION ON THE RABBIT'S EYE*

By WILLIAM F. HUGHES, JR., and CHARLES E. ILIFF

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PREVIOUS studies on the effect of irradiation on the eye have been concerned largely with roentgen rays and gamma rays of radium. Clinically, the beta rays of radium have been used extensively in ophthalmology for the treatment of a wide variety of conditions affecting the con-

junctiva and cornea. The dosages used for such treatments have been determined empirically without satisfactory knowledge of the range of tolerance of the normal ocular tissues for a single dose of beta irradiation or the cumulative effects. Also, individuals may show apparent differences in tissue sensitivity to beta rays.

The effective use of beta irradiation requires an exact knowledge of the differential between the sensitivity of normal tissues and the pathologic tissues to be treated. It is the purpose of this study (1) to standardize the technique of applying beta irradiation to the eye, controlling such factors as the distance of the applicator from the eye, the size of the area irradiated, and the site of application; (2) to determine the tolerance of the normal tissues of the anterior ocular segment for beta irradiation; and (3) to describe the clinical and pathologic characteristics of the lesions produced by various doses with special references to the differences in reactivity between the cellular components of the conjunctiva and cornea.

The absolute dosages determined for the rabbit's eye in these experiments are not necessarily applicable to the human eye. However, the important features in the technique of application, the differences in sensitivity between various cellular components, the principles of cumulative effects, and the general characteristics of beta irradiation burns are probably similar in the rabbit and human eye.

MATERIALS AND METHODS

The Burnam applicator¹ for beta irradiation was used in these experiments (Fig. 1-3). In this applicator, the glass capsule containing the radium emanations or radon

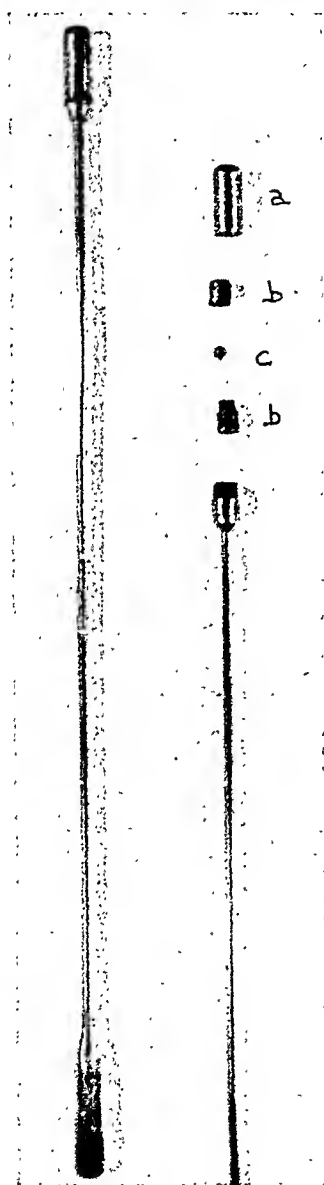


FIG. 1. Photograph of the Burnam beta-ray applicator with a side view of the disassembled tip showing (a) the brass holder with walls 2 mm. in thickness, (b) container for the glass capsule, and (c) glass capsule containing the radon.

* From the Wilmer Ophthalmological Institute of the Johns Hopkins Hospital and University, Baltimore, Maryland.

is held in a brass tube of walls 2 millimeters in thickness. This prevents the escape of beta rays except through a 4 mm. opening at the end of the applicator. The glass bulb containing the radon is located 1 mm. from the end of the tube, and the thickness of the glass is sufficient to prevent the escape of alpha particles. Gamma rays are emitted simultaneously with the beta rays but only in comparatively low concentration, a ratio of approximately 100 electrostatic units of ionization produced by the beta rays to 1 unit produced by the gamma rays. Accordingly, therapeutically useful doses of beta rays can be applied without significant gamma irradiation.

In early experiments, the applicator was held either manually or fixed in a ring stand



FIG. 3. Photograph showing treatment of the proposed rabbit's eye with Burnam beta-ray applicator and lucite contact glass.

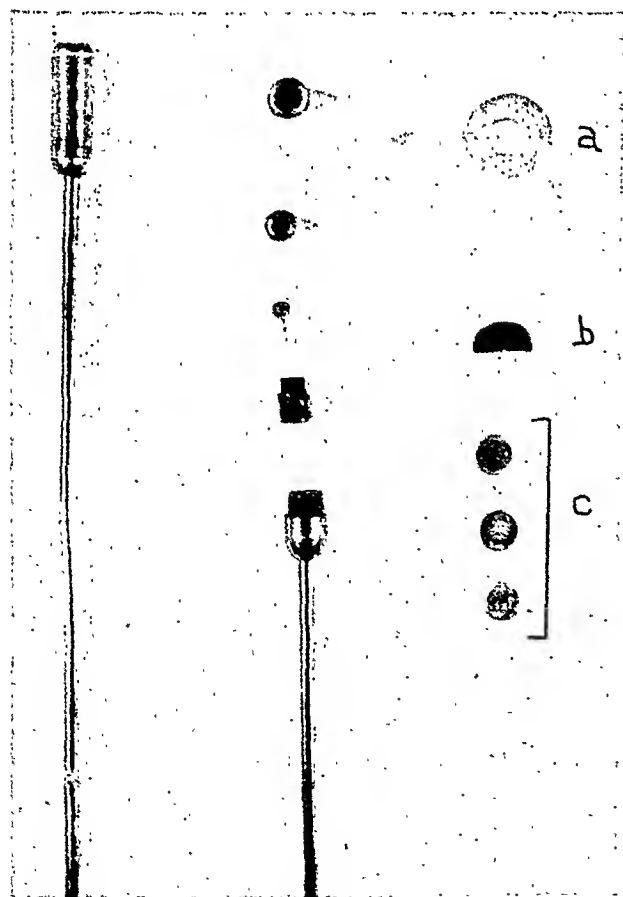


FIG. 2. Photograph of the Burnam beta-ray applicator, an end view of the disassembled tip, and (a) an end view of the lucite contact glass holder for the head of the applicator, (b) semicircular lead protector for localization of the irradiation, and (c) aluminum filters which can be inserted into the lucite holder.

about 5 mm. above the rabbit's eye. Although the rabbits were anesthetized with ether during treatments, the eyes could not be kept entirely stationary. In order to eliminate such variations in the distance of the applicator from the eye and the size of the area treated, a contact glass holder made of lucite was designed for the beta applicator (Fig. 2 and 3). When this was placed directly on the rabbit's eye, the glass bulb containing the radon was held constantly 6 mm. above the site of application (Fig. 3), and an area 11 mm. in diameter was exposed. In some experiments, thin discs of aluminum were inserted into the upper part of the contact glass to screen out part of the beta rays. To protect the cornea during the treatment of a sector of the limbus, a semicircular piece of lead was inserted into the end of the contact glass in certain experiments.

In these experiments, the dose of beta irradiation has been recorded in terms of gram-seconds of radium because of the ease with which the time exposure in seconds can be calculated from the strength of the radium in milligrams or its equivalent of radon in millicuries; for example,

$$\text{No. sec. exposure} = \frac{\text{No. gram sec. desired} \times 1000}{\text{No. mg. radium or No. millicuries of radon.}}$$

For conversion into the international dosage unit "milligram-hours" the number of gram-seconds must be multiplied by the factor 0.278 thus:

$$\text{No. milligram-hours} = \text{No. gram-seconds} \times \frac{1000}{60 \times 60}$$

Mongrel rabbits were used except albino or black animals. The weight of the rabbits ranged between 4 and 6 pounds, and all the

TABLE I

SCALE FOR GRADING THE SEVERITY OF OCULAR LESIONS PRODUCED BY BETA IRRADIATION

	Maximum Grade
<i>Corneal</i>	
Opacification: density \times area = 4×4	16
Vascularization:	3
Ulceration: +4 = perforation = 100% corneal lesion regardless of other values	4
Edema:	3
Total points for estimation of corneal lesion	24 = 100%
Duration of corneal opacity: 14 days and over	4
<i>Conjunctival</i>	
Redness	2
Edema	3
Necrosis (petechial hemorrhages or ischemia)	2
Mucopurulent discharge	2
<i>Iritis</i>	3
Total points for estimation of ocular lesion	40 = 100%

"Maximum ocular reaction" = sum of the maximum values for each symptom during the course of observation, and conversion of the total to a percentage figure. This gives an index of the acuteness of the reaction.

"Final corneal opacity" = sum of the values of the corneal symptoms on the last day of observation, a total of 24 points or corneal perforation representing a 100% lesion. If the cornea became clear, the day on which this occurred is recorded.

animals were at least four months old. During treatments under ether anesthesia, the eyes were popped out between the lids and maintained in that position by clamping the lids behind the globe.

A numerical estimation of the severity of the lesions produced by beta burns was made by using a modification of methods previously outlined² (see Table I).

STANDARDIZATION OF TECHNIQUE AND DOSAGE

1. *Without Contact Glass Applicator.*

Twenty-four normal rabbit eyes were exposed to varying doses of beta irradiation holding the Burnam applicator as steadily as possible about 4-6 mm. above the center of the cornea. The ocular reactions following these exposures showed considerable variation in intensity. Doses of 100 gram-seconds or less produced little more than a transitory conjunctival reaction with punctate erosions of the corneal epithelium stainable with fluorescein. A transitory haziness of the cornea appeared after exposure to doses of 24 gram-seconds and over. Three eyes exposed to 200 gram-seconds developed moderately severe conjunctival and corneal lesions, and one cornea exposed to 250 gram-seconds had perforated by the twenty-fifth day.

2. *With Contact Glass Applicator.* When the beta applicator was held constantly by the contact glass 6 mm. above the center of the cornea covering an area of about 11 mm., the lesions were more severe than those produced without the contact glass holder (Table II). No significant corneal reaction followed an exposure of 18 gram-seconds. Exposures of 24-36 gram-seconds produced a faint haziness of the cornea with punctate staining by fluorescein. Exposures of 50 and 60 gram-seconds resulted in moderate corneal damage, still present after nineteen days. Eyes exposed to 75 gram-seconds developed rather severe conjunctival and corneal symptoms, resulting in perforation of the cornea in several instances.

3. *Comparison of Both Eyes in the Same*

Animal. A comparison of the severity of the ocular reaction produced by beta irradiation in opposite eyes of the same animal affords an estimation of the variability in technique of application. Both eyes of 5 rabbits were exposed to 75 gram-seconds using the contact glass applicator. The average difference in the maximum ocular reaction between the two eyes of each animal was only 6 per cent (standard deviation of the different values from the mean = 6

having an average residual corneal opacity of 54 per cent and 46 per cent respectively. Therefore, a standard deviation of 25 per cent in the severity of the average final corneal opacity after thirty-two days was present in these 5 animals.

5. *Localization of the Lesion.* The damaging effect of beta irradiation appeared to be localized to the site of application, especially when smaller doses were used. The area of corneal opacification and edema

TABLE II

SEVERITY OF OCULAR REACTIONS PRODUCED IN NORMAL RABBIT'S EYES BY BETA IRRADIATION USING BURNAM APPLICATOR AND LUCITE CONTACT GLASS

Dosage and Site (No. gram-seconds)	No. Eyes	Maximum Ocular Reaction Per Cent	Final Corneal Opacity Per Cent	Day of Final Reading	Corneal Erosion
18 gm-sec. cornea	1	1	0	13	Doubtful
24 gm-sec. cornea	4	2	1	13-32	Slight punctate staining
30 gm-sec. cornea	4	2	2	13-32	Slight punctate staining
36 gm-sec. cornea	4	3	2	13-47	Punctate staining
36 gm-sec. limbus	1	1	0	47	Doubtful
50 gm-sec. cornea	1	17	16	19	Superficial
60 gm-sec. cornea	1	25	19	19	Superficial
75 gm-sec. cornea	10	72 (SD = 17)*	80 (SD = 25)	32	Perforation (6 eyes) Superficial (5 eyes)
100 gm-sec. cornea	1	33	35	19	Superficial
200 gm-sec. cornea	1	94	100	47	Perforation
200 gm-sec. limbus	1	31	12	47	Superficial

* SD = standard deviation of the mean.

per cent). Only one rabbit showed any difference in the corneal opacity of the two eyes after 32 days, an average difference for the series being 1.6 per cent (standard deviation = 3 per cent). This indicates that the dosage of beta irradiation can be applied with some accuracy by this technique.

4. *Variation in Individual Sensitivity to Beta Irradiation.* A comparison of the ocular reaction produced by the standard dose of 75 gram-seconds among different rabbits revealed large differences in reactivity. A standard deviation of 16 per cent in the maximum ocular reactions was obtained for the differences between the 5 rabbits. Perforation of both corneas occurred in three animals, the other 2 rabbits

was usually limited to the diameter of the contact glass. However, with doses of 75 gram-seconds or over, the lesion spread beyond the exposed area of 6 mm. and involved most of the cornea. These changes were somewhat late, and might be accounted for by secondary processes such as spreading of edema throughout the entire stroma, an inflammatory reaction, and corneal vascularization. When precautions were taken to protect the cornea, the limbal region tolerated an exposure of 75 gram-seconds, without secondary corneal involvement. One eye which received a single application of 200 gram-seconds at the limbus developed a maximum ocular reaction of only 31 per cent and a small

opacity of the adjacent cornea. The opposite eye of this animal received 200 gram-seconds to the center of the cornea and developed a 94 per cent maximum ocular reaction with perforation of the cornea.

6. *Screening.* In a few experiments, aluminum discs of varying thicknesses were placed over the end of the beta-ray applicator within the contact glass holder. As to be expected, the intensity of the reaction was

bit's eye resulted in a migration of the limbal pigment over the surface of the cornea although no definite staining with fluorescein was detected. Histologically also, there was some disturbance of the corneal epithelium after exposure of the eye to 75 gram-seconds with the 0.30 mm. filter and to a less extent with the 1 mm. filter. No evidence was obtained that the filtered beta rays produced deeper lesions

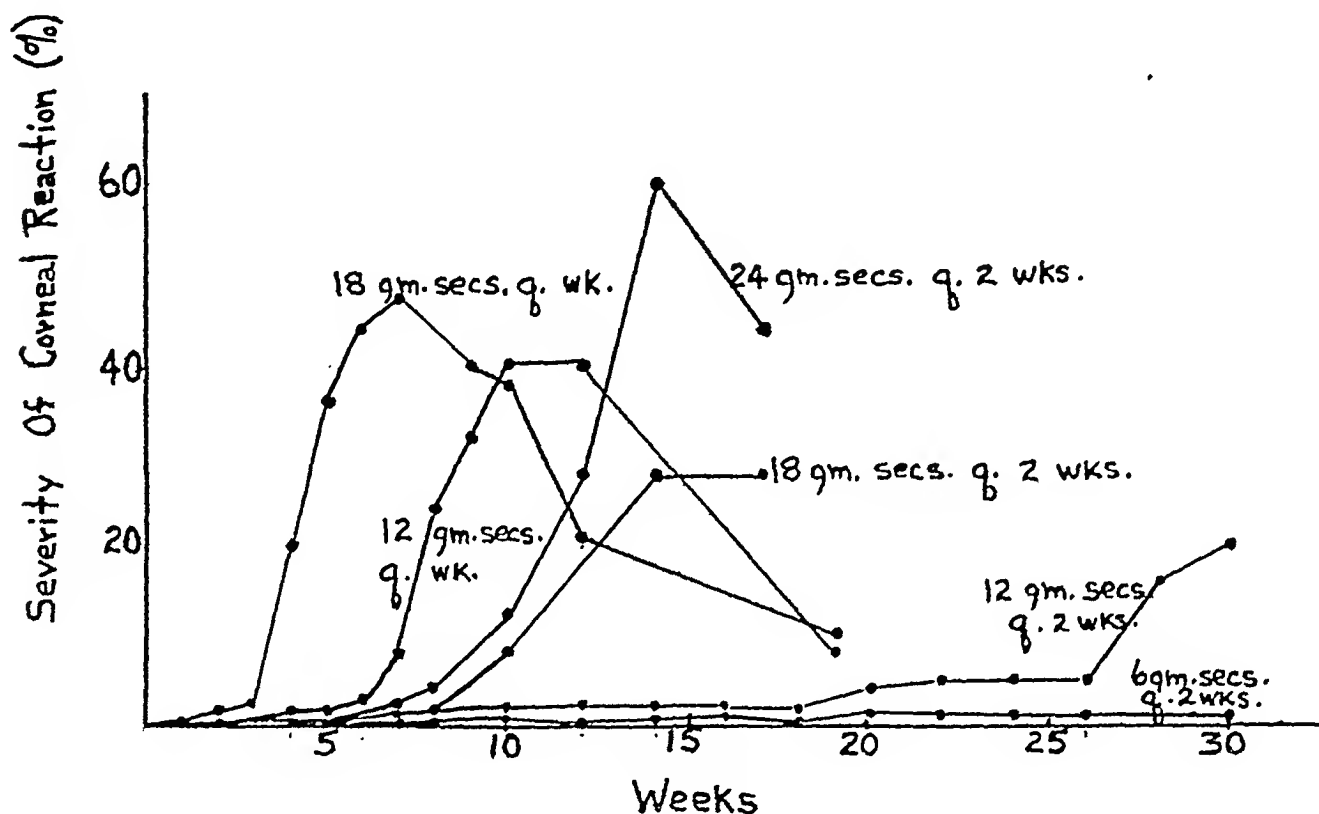


FIG. 4. Cumulative effects of repeated small doses of beta irradiation on the rabbit's eye. Each curve represents the average of two eyes in different animals. One rabbit proved resistant to repeated doses of 12 gram-seconds and 18 gram-seconds every week for ten weeks in opposite eyes, obtaining a maximum corneal reaction of 6 per cent and 10 per cent respectively. Exposures were discontinued two weeks before each maximum peak of reaction.

reduced; e.g., exposure of 300 gram-seconds through a 1 mm. filter produced only a superficial punctate erosion of the corneal epithelium, 300 gram-seconds with a 0.43 mm. filter produced a corneal lesion comparable to that seen after a 50–60 gram-seconds unfiltered exposure, and 300 gram-seconds with a 0.30 mm. filter produced a somewhat more severe lesion. The corneal epithelium was not completely spared by such screening. Application of 48 gram-seconds with a 0.30 mm. filter over the limbal region of a heavily pigmented rab-

than the unfiltered beta rays, with relative sparing of the epithelium.

Using the contact glass with semicircular lead protector, a 75 gram-seconds exposure resulted in a minor semicircular opacity of the cornea, not only smaller but also less intense than that obtained without the lead protector.

CUMULATIVE EFFECTS

The possibility of cumulative effects after repeated exposures to irradiation is well recognized clinically. This phenome-

non was demonstrated in this study on rabbit corneas using varying doses spaced at one or two week intervals (Fig. 4). With applications weekly, corneal damage became manifest after four exposures of 18 gram-seconds, and an equally severe lesion developed after eight exposures of 12 gram-seconds. Biweekly applications of 24 or 18 gram-seconds produced a slight corneal lesion after five exposures and a moderate lesion after six exposures. Ten biweekly exposures of 12 gram-seconds induced a mild lesion and 14 exposures a moderate lesion. After 15 biweekly exposures of 6 gram-seconds, nothing more than a faint haziness of the cornea with irregular punctate staining with fluorescein was noted clinically.

The onset of the corneal lesion therefore appeared earliest after larger doses and after more frequent applications. Although no strict quantitative relationships can be elicited from these data, it required greater total dosages to produce equally severe (20 per cent) corneal lesions when either smaller individual doses were administered or when exposures were less frequent. This is probably dependent on the degree of recoverability of the tissues, most pronounced when the dosage of beta is low or when more time is allowed between treatments.

The individual doses used for these experiments did not produce significant clinical lesions in the rabbit's cornea, except for mild punctate staining of the epithelium with fluorescein. A series of histological preparations was therefore made to see if structural changes could be detected microscopically in the cornea at the end of one and two weeks following a single exposure to those small doses of beta; 6, 12, 18, and 25 gram-seconds respectively. All specimens showed changes in the epithelium, somewhat more pronounced at two weeks than at one week after exposure.

Histological sections were made of the eyes which had received 6 or 12 gram-seconds of beta radiation every two weeks for twenty-eight weeks, enucleation being performed four weeks after the last expo-

sure. The two eyes which received repeated doses of 6 gram-seconds showed slight irregularity in the thickness of the corneal epithelium, and many cuboidal cells characteristic of regenerating epithelium. The corneal stroma appeared normal. Eyes which were exposed repeatedly to 12 gram-seconds showed advanced changes in both epithelium and stroma, including loss of stroma cells, edema and vascularization.

PATHOLOGY OF BETA IRRADIATION BURNS

Time of Onset. The time at which clinical lesions first appeared varied inversely with the dosage of beta irradiation applied to the rabbit's cornea. In general, signs of damage to corneal epithelium or stroma did not appear prior to one week after exposures of 36 gram-seconds or less. With doses of 75 gram-seconds or more, punctate staining of the cornea with fluorescein usually could be demonstrated within twenty-four hours, but easily detectable haziness of the stroma ordinarily did not appear until after forty-eight hours. The onset of histological changes in the corneal epithelium also was directly related to the degree of exposure; definite changes after exposures of 6, 12, 24, 75, and 200 gram-seconds appearing at ten, seven, six, two and one days respectively.

Depth of Lesion. The dosage was also found to be related to the depth at which lesions appeared. Little more than a punctate staining of the corneal epithelium and questionable haziness of the stroma were produced by exposures of 18 gram-seconds or less. Transitory corneal haziness occasionally appeared after exposures of 24-30 gram-seconds, but 36 gram-seconds usually produced a slight but definite cloudiness of the stroma which cleared within a few weeks. Two eyes exposed to 50 and 60 gram-seconds respectively had persistent corneal opacification of 16 per cent and 19 per cent at the end of nineteen days. Exposures of 75 gram-seconds and over regularly produced clinical damage to the corneal stroma of such an extent that permanent corneal scarring remained. The

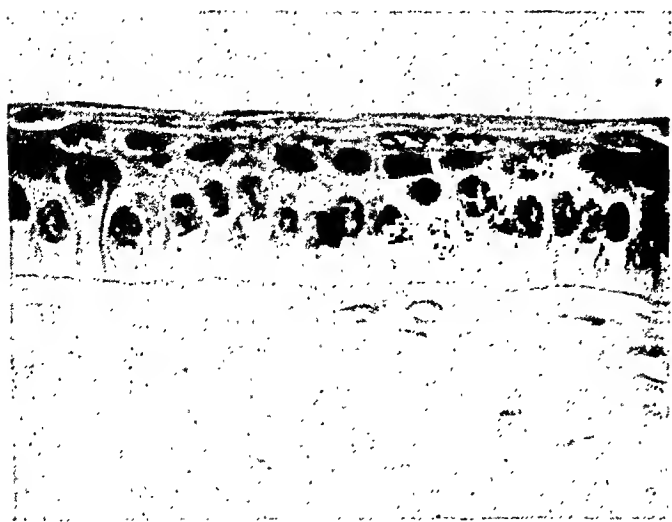


FIG. 5. Section taken eight hours after exposure of 75 gram-seconds, showing peg-shaped basal cells of corneal epithelium and anterior displacement of the nuclei.

severity of the iritis roughly paralleled the dosage, but this was probably related to the intensity of the associated corneal lesion. No irradiation cataracts were observed in any of these animals, some of which received as much as 250 gram-seconds to the cornea. None of the animals exposed to doses of 300 gram-seconds through aluminum filters 0.3 to 1.0 mm. in thickness developed cataracts, indicating that the amount of beta and gamma rays which might have penetrated through the cornea was insufficient to damage the lens.

Conjunctiva. The conjunctival reaction following application of beta irradiation to the center of the cornea consisted of a transitory edema and congestion lasting several days. Severe corneal burns were also accompanied by mucopurulent discharge in the conjunctival cul-de-sacs, probably a result of secondary infection. When relatively large doses of beta rays were applied directly to the bulbar conjunctiva (e.g., 18-24 gram-seconds with the applicator directly in contact with the conjunctiva), the necrosis of conjunctiva and superficial blood vessels was followed by scarring and contracture of the conjunctiva to such an extent that the cul-de-sacs were occasionally obliterated, with a fold of conjunctiva drawn onto the surface of the cornea.

Corneal Epithelium. Exposures as little as 6 gram-seconds produced changes in the corneal epithelium visible under the slit lamp, such as fine edema or bedewing, pitting of the surface stainable in punctate fashion by fluorescein, filamentary tags of loosened epithelium, and occasionally small bullae. Loosening and desquamation of the epithelium was uncommon except when associated with extensive damage to the underlying stroma. Regeneration of the epithelium was often accompanied by a migration of limbal pigment onto the surface of the cornea.

Histologically, the earliest changes in the epithelium visible at twenty-four hours after exposure to 75 gram-seconds consisted in an elongation of the basal cells with anterior displacement of the nuclei (Fig. 5). At forty-eight hours, the cell boundaries were in many places indistinct or absent, the cytoplasm had become increasingly rarefied, the cell nuclei showed minor variations in size and overlapped each other (Fig. 6). Seven days after exposure (Fig. 7), the normal arrangement of cells had become completely disorganized although epithelium remained attached to the underlying stroma. The nuclei showed extreme variations in size, for the most part being larger. The nuclear membranes remained intact, but the chromatin formed small darkly staining clumps in many cells. A few cells appeared to have two heavily staining

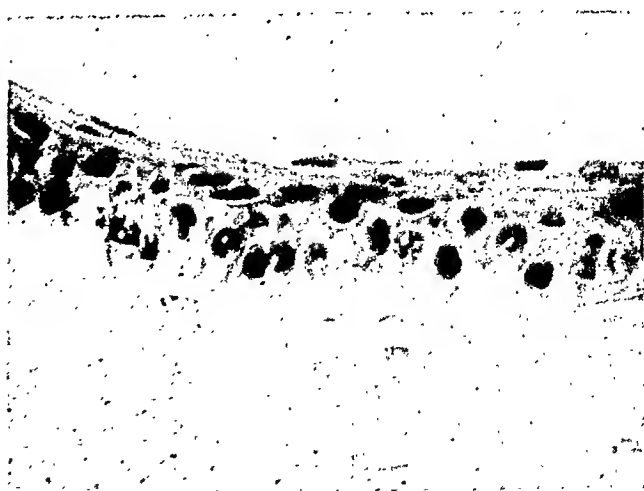


FIG. 6. Section of corneal epithelium taken forty-eight hours after an exposure of 75 gram-seconds.



FIG. 7. Section of corneal epithelium taken seven days after an exposure of 75 gram-seconds.

nuclei within a single cell membrane. These changes do not appear after exposure of the cornea to 75 gram-seconds of gamma irradiation in which the beta rays have been filtered out by a brass screen 2 mm. in thickness. Extremely irregular formations of epithelial cell nuclei often remained attached to corneal stroma which was entirely acellular, vascularized or scarred (Fig. 8). The appearance of regenerating cells was often delayed for two to four weeks after exposure (Fig. 9).

Corneal Stroma. In burns severe enough to involve the corneal stroma, an edema

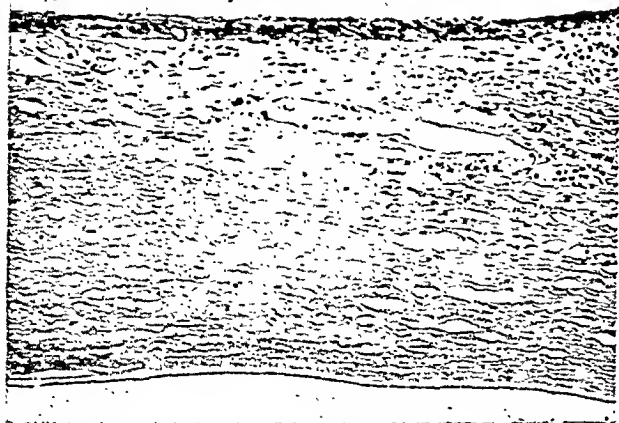


FIG. 8. Section of cornea taken near the limbus twenty-one days after exposure to 75 gram-seconds. There is no evidence of regeneration of the corneal epithelium. Superficial vascularization and a small number of inflammatory cells have entered the anterior layers of the cornea.

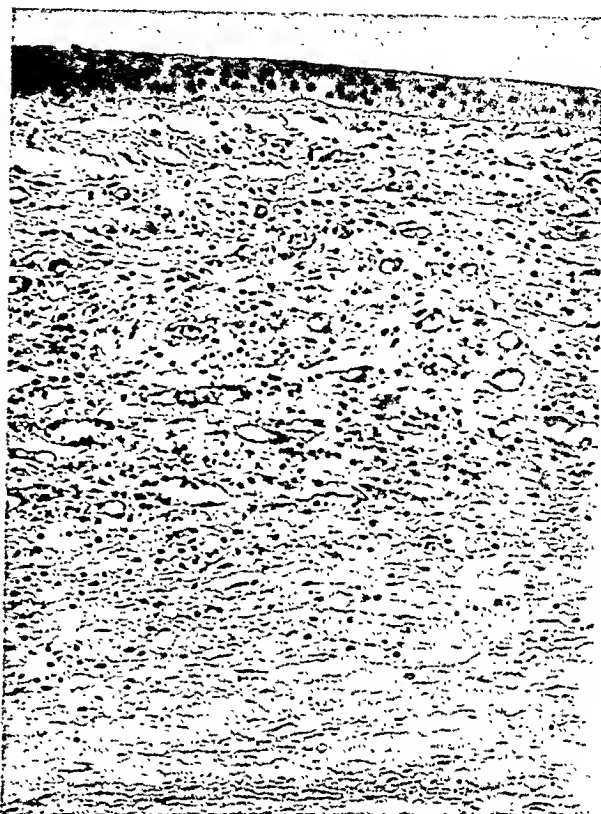


FIG. 9. Section taken thirty-two days after exposure to 75 gram-seconds. The corneal epithelium has regenerated over a heavily vascularized stroma.

first appeared in the superficial layers as clear areas with interspersed flocculent white spots (Fig. 10). Such edema usually spread into the deeper layers of the cornea, and to a variable extent laterally. Within



FIG. 10. Photograph of rabbit's cornea, ten days after exposure to 75 gram-seconds. The area of exposure exhibits only a mild haziness with edema of the stroma.

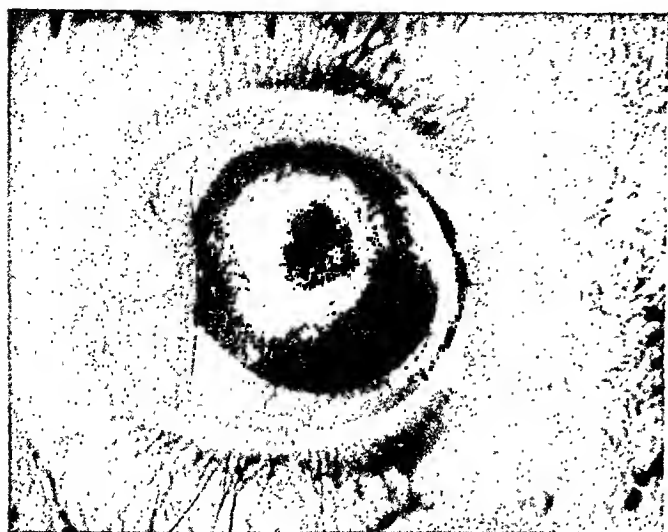


FIG. 11. Photograph four weeks after an exposure to 300 gram-seconds using a 0.43 mm. aluminum filter. Extreme edema of the stroma has developed into a staphyloma, some crystalline deposits are present below and the cornea is heavily vascularized.

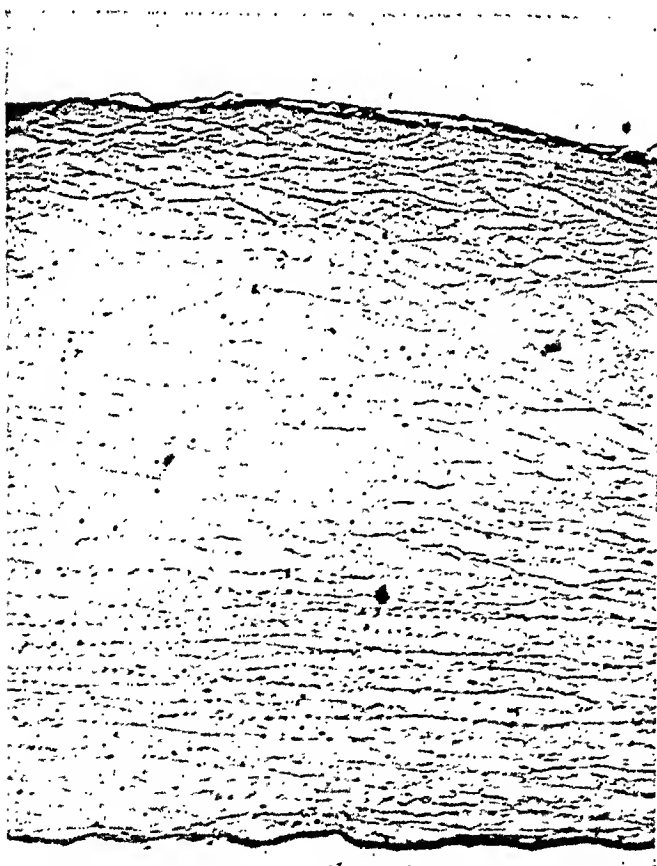


FIG. 12. Section taken fourteen days after exposure to 75 gram-seconds, showing loss of all but a few remnants of corneal epithelium, disappearance of most of the cells of the stroma with the presence of moderate edema, and desquamation of the endothelium.

twelve to sixteen days, limbal blood vessels entered the cornea nearest the site of maximal damage. The tips of these vessels were often bulbous in shape. In milder burns, the corneal edema gradually subsided during the next few weeks leaving a thin opacity of granular consistency or with a silky sheen. More intense exposures produced ulceration of the cornea, occasionally some corneal infiltration, and in one instance a sequestrum-like area of tissue which sloughed (Fig. 11). Such corneas healed by dense white scarring and abundant vascularization.

Histologically, edema of the stroma and

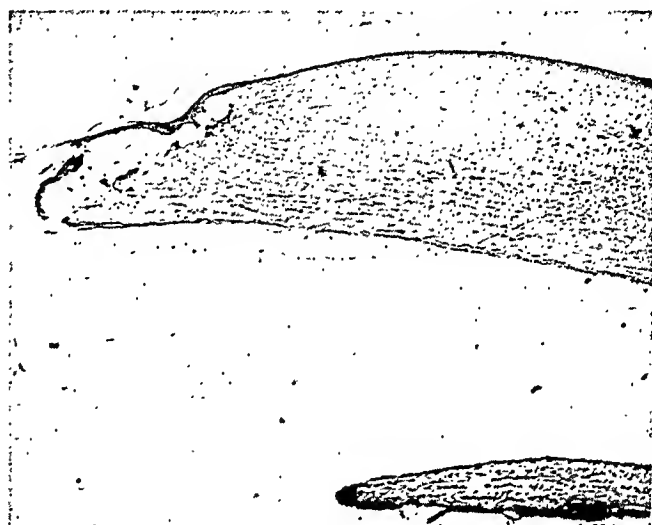


FIG. 13. Same section as in Figure 9, showing a central perforation of the cornea into which epithelium has grown. The zone immediately adjacent shows practically no cellular reaction.

disappearance of its cells were detected between two and ten days after exposure of 200 gram-seconds and 75 gram-seconds respectively (Fig. 12). A few mononuclear wandering cells were found in the burned area, but strikingly few polymorphonuclear cells. A moderate number of thin, darkly staining elongated cells could be seen at the peripheries of the lesion. The corneal endothelium disintegrated after exposure of this degree, and did not regenerate for two or three weeks. After fourteen to twenty-one days, blood vessels entered peripherally (Fig. 8) and profusely vascularized all layers of the cornea (Fig. 9). Ulceration and sloughing of the acellular stroma occurred

at times without much inflammatory reaction, resulting in perforation (Fig. 13). Sites of perforation were usually plugged by iris tissue and the proliferation of fibrous tissue.

Iris. The intensity of the iritis varied with the severity of the corneal lesion. The aqueous ray did not become positive until approximately forty-eight hours after a severe exposure. The iris frequently became congested and swollen within seven to ten days. On one occasion Koeppe nodules appeared, and occasionally a hypopyon developed. Residual scarring, atrophy, or depigmentation of the iris were infrequent. It would therefore seem reasonable to suspect that the reaction produced in the iris was secondary to the corneal involvement rather than a result of any direct necrotizing action of the irradiation.

Histologically, a little serum and a few inflammatory cells were ordinarily found in the anterior chamber a week or two after exposure. The iris vessels later became dilated, but cellular infiltration or evidence of necrosis in the iris were not encountered. Sections taken at six hours and twenty-four hours after exposure to 200 gram-seconds showed some mononuclear cells and a few polymorphonuclears in the posterior chamber, and the section at forty-eight hours revealed edema of the ciliary processes, but subsequent sections at three days and thereafter revealed no abnormality of the ciliary processes.

Lens. No evidence of lens damage was noted in any of the beta irradiation burns. The severe lesions, in which the corneas perforated, were followed about two months, and the eyes subjected to exposures of 12 gram-seconds every two weeks were followed for eight months.

DISCUSSION

1. *Changes in the Corneal Epithelium.* The histological changes in the corneal epithelium following exposure to beta irradiation illustrate several of the changes also described after exposure to roentgen rays or gamma rays in other epithelial structures. The basal layers of the corneal

epithelium are affected most, the superficial stratified layers showing few alterations. This is probably related to the increased sensitivity of these basal cells which are the most immature and in which the mitotic activity of the corneal epithelium occurs. The initial histological changes after exposure to beta rays appears as a rarefaction and disorganization of the cytoplasm and outlines of the cell membranes. Later, many of the nuclei become swollen and the chromatin becomes clumped in small darkly staining masses, but the nuclear membrane temporarily remains intact. The rarefaction of cytoplasm and later swelling of cell nuclei because of edema has been repeatedly described after exposure to roentgen rays and gamma rays, and is considered by Failla³ to be an important contributing factor in the destruction of the cell. Some of the peculiar formations of chromatin and binucleated cells after exposure to beta rays resemble abnormal mitoses. The nuclear fragmentation after beta irradiation is not unlike that seen after several other types of injury such as ultraviolet irradiation, mustard gas and the nitrogen-mustards.⁴

2. *Regeneration.* All layers of a beta-burned cornea show evidence of retarded regenerative processes when compared to that seen after injury by heat, cold, mechanical injury and chemical burns. It is possible that the persistence of the irregular and disorganized corneal epithelium obstructs the proper regeneration of epithelial cells which ordinarily slide over the surface of the damaged area. Relatively few new spindle-shaped cells appear at the periphery of the burned stroma, and the endothelium regenerates late. Vascularization appears somewhat later than for other lesions with equal corneal opacification. No evidence of any stimulating effect was found in these experiments.

3. *Depth of Beta Irradiation Effects.* Beta rays have a penetrability of about 1 cm. in tissue.⁵ However, since only a small fraction of the total dose will penetrate this deeply, most of the rays are absorbed by the cornea

and aqueous before striking the lens. We observed no cataract formation after exposures as much as 200 gram-seconds unfiltered or 300 gram-seconds partially filtered beta irradiation. For irradiation of low intensity, e.g., 6 gram-seconds, the pathologic effects are almost entirely limited to the epithelium, but the stromal cells and endothelium are readily affected by increasing the dose to 24-36 gram-seconds. The iris shows no effects of necrosis after severe beta-ray exposures, and the accompanying iritis is probably secondary to the corneal lesion.

4. *Possible Applications of this Information to Clinical Treatment.* Beta irradiation produces a localized destruction of tissue, delays processes of regeneration, and has no stimulating action. It should therefore be used with care for any corneal condition in which there has already been cellular destruction, because the effects might reasonably be expected to be additive in character, and to inhibit any regenerative processes which might be taking place.

The tissue reaction to be expected from a single exposure of beta rays varies greatly among different individuals, especially with techniques which do not accurately localize the area treated and maintain a constant distance of the applicator from the eye. The use of a contact glass applicator was designed to eliminate variations in the dosage applied to any localized area.

The depth at which beta irradiation effects are produced is somewhat dependent on the dosage, but the iris and lens are safe from ill effects even with doses which destroy the cornea.

SUMMARY AND CONCLUSIONS

The effects of beta irradiation from radon

on the normal rabbit's eye are described. In addition to inherent differences in reactivity among individuals, variations in technique of application yield uncertain results. In order to control accurately the distance of the applicator from the eye and the site and size of the area treated, a contact glass holder for the beta applicator is described. Low doses of beta irradiation affect primarily the epithelium. Larger doses can affect all layers of the conjunctiva and cornea, but the iris and lens are not damaged. Strong exposures to beta rays are followed by a latent period free of clinical or histologic changes, the length of this period varying inversely with the dosage. Changes thereafter include: (1) disorganization of the corneal epithelium, especially loss of cytoplasm, variation in size and shape of the cells, and alterations in the chromatin; (2) loss of stromal cells; (3) desquamation of corneal endothelium with edema of the stroma, (4) relatively little inflammatory cell reaction, (5) secondary iritis, and (6) late regenerative changes. The cumulative effects of repeated doses of beta radiation is described.

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REFERENCES

1. BURNAM, C. F., and NEILL, W., JR. Use of beta ray of radium applicator. *South. M. J.*, 1940, 33, 279-286.
2. FRIEDENWALD, J. S., HUGHES, W. F., JR., and HERRMANN, H. Acid-base tolerance of the cornea. *Arch. Ophthalm.*, 1944, 31, 279-283.
3. FAILLA, G. Some aspects of biological action of ionizing radiations. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 44, 649-664.
4. FRIEDENWALD, J. S., and BUSCHKE, W. To be published.
5. DESJARDINS, A. U., and WILLIAMS, M. M. D. *Radium. J.A.M.A.*, 1946, 130, 207.



CANCER OF THE CERVIX

A STUDY OF THE EFFECT OF INTERSTITIAL RADON NEEDLES AS COMPARED WITH ROENTGEN THERAPY GIVEN THROUGH INTRAVAGINAL CONES

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THIS report is a preliminary survey of the comparative effects in the treatment of cancer of the cervix of radon needles introduced into the parametria and of roentgen therapy directed at the cervix and vaginal fornices through a small lead-lined cone. The study is based on 254 primary cases of cancer of the cervix treated at the Memorial Hospital during 1943 and 1944. On account of the short period of time that has elapsed, conventional five year cure rates are not available, but the two groups were so set up as to afford the basis for a satisfactory comparison. The results in the two groups have been so strikingly different that a brief account of them at this time seems warranted.

The work here to be reported represents a second effort to isolate and study in relation to end-results special factors in treatment. A previous report⁵ analyzed the effects on the five year cure rate of different techniques of external roentgen therapy given in relation to a constant method of radium application to the uterus. The two methods compared consisted in the so-called "*massive dose technique*" of pelvic roentgen therapy, i.e., 750 r at a single treatment to each of four pelvic fields, 50 cm. target-skin distance, 200 kv., 0.5 mm. copper filtration and the "*divided dose technique*," i.e., twelve treatments of 200 r each to each of six fields, 70 cm. target skin distance, 200 kv., 0.5 mm. copper filtration. With each type of external roentgen therapy, radium application was made by means of two radium capsules within the cervix, delivering 3,000 millicurie-hours and by a vaginal applicator or "bomb," delivering 1,500 mc-hr.

During the years 1932 to 1937 there were

treated 920 cases of cancer of the cervix at the Memorial Hospital. Three hundred and eighty-seven cases were considered suitable for studying the relative merits of the two methods of treatment. Analysis showed that among 288 cases receiving the "divided dose technique" there were five year cures in 35.4 per cent; in the 99 receiving "massive dosage," there were 28.5 per cent. Similarly for three year cures, the "divided dose" yielded 36.1 per cent in 163 cases, the "massive dose" 30.2 per cent in 363 cases.

A careful study of this material indicated that these differences were not due to a selection of unfavorable cases for the "massive dose" type of treatment. Rather did corrections for extent of disease, age of patient, and pathological grade tend to emphasize the superiority of "divided dose technique." With this study as a base, it has been the policy of the gynecological service since January, 1943, to treat all patients with some form of "divided dose technique" as far as external pelvic roentgen therapy is concerned.

The next step seemed to be the search for the best method of application of radiation internally to cervix and parametria.

When this study was commenced, the usefulness of the vaginal radium applicator—the so-called "bomb"—was immediately questioned by the physics department of the Hospital. It was pointed out that because the radium in this applicator was placed almost in contact with the cervix, the dosage received by tissues below the surface of the tumor must be very low. The radiation reaching the parametria more than 2 cm. from the cervix was largely contributed by the external roentgen ther-

apy. The effect of the bomb in the lateral fornices or on the upper portions of the cardinal ligaments was almost negligible.

A perusal of the literature suggested two contrasting methods of treatment which might replace the vaginal bomb and greatly increase the radiation delivered to the parametria. The first of these was the use of interstitial radium by radon needles introduced directly into the parametria through the vaginal vault. This method was not a new one, but clinical reports by Teahan, Wammock and Weatherwax,¹³ by Arneson and Hauptman,² and especially by Pitts and Waterman^{10,11} had been very optimistic. Indeed the last authors reported a five year survival rate of 36 per cent in a series of 264 patients, about the highest survival rate for any large series of cervical cancer reported in this country. Recently Waterman and Di Leone¹⁵ have reported a 39.3 per cent five year cure rate in 127 cases treated in 1936 to 1938.

The second method, as a possible improvement on the radium "bomb," was roentgen therapy given through a cone or cylinder introduced into the vagina. This also is an old method, having been suggested by Allen¹ as long ago as 1904. Merritt⁸ had given treatments to the cervix exposed by special Ferguson specula equipped with obturators for introduction and shields at the skin surface. Erskine⁴ had developed a series of ingenious expanding specula for treatment at short target skin distances, the purpose being to include both parametria in a single beam. More recently Wasson¹⁴ has described the use of a series of cylinders made of brass to be attached to a low voltage shock-proof machine and to be aimed at different areas in the upper end of the vagina. In Germany, Martius and Witte⁷ have worked for many years on various forms of intravaginal roentgen tubes. The results of their use of the most satisfactory model have been described by Martius,⁶ who finds an increase in total five year cures for "Group III and IV" cases from 23.5 per cent to 33.3 per cent by this method.

CASE MATERIAL

One technique of irradiation cannot be satisfactorily compared with another, when these methods are applied in different clinics because of differences in the character of the original case material. Even within a single clinic a dependable conclusion cannot be reached by comparing the results obtained by one method in one period of years with those obtained by another method in subsequent years, because of the probable effects of educational campaigns in bringing earlier cases.

It is almost essential that both methods for study be employed simultaneously and in the same clinic, the cases as they apply for treatment being carefully and fairly assigned to one or the other method.

To show that classification of cancer of the cervix according to the extent of the disease is not an exact procedure but depends greatly on the judgment and attitude of the examiner, the distribution of cases to various stages during the years of this study and in the cases of the 1932-1937 series⁵ may be cited. In the earlier series it was found that 15.9 per cent were Stage I, 32.9 per cent Stage II, 45.7 per cent Stage III, and 1.8 per cent Stage IV. In the present group, 20.3 per cent were classified as Stage I, 45 per cent Stage II, 28.3 per cent Stage III, and 6.4 per cent Stage IV. The difference may be attributable in part to an actual improvement in case material, but certainly also to a partial change in the staff examining these patients.

To obtain groups as nearly comparable as possible, the following procedure was adopted. All cases of cancer of the cervix were examined as they came to our clinic by one of the two of us. The cases were classified according to the League of Nations classification as modified in 1937,³ which may be simply stated as follows:

Stage I included all cases in which the tumor was confined to the cervix.

Stage II included those cases with parametrial or upper vaginal involvement, but no fixation.

Stage III consisted of the cases with fixation of the parametria on one or both sides, or with

involvement of the lower vagina. This stage included some cases with "frozen pelves."

Stage IV contained the cases with metastatic disease outside the true pelvis or actual invasion of the bladder or rectal mucosa by tumor.

After examination, a diagram of the examiner's concept of the extent of the disease was drawn and the stage of the disease decided. The case was then placed, without the knowledge of the examiner, either in Group A to be treated by intravaginal cones or Group B to be treated by radon parametrial needles. In each stage the cases were alternately put into Group A or B.

Both of the methods were, on physical grounds at the beginning of the work, considered to be superior to the original radium bomb. The alternation was considered justifiable since in the beginning there was no ground for considering the vaginal cones or the needles superior. Toward the end of the second year when definite differences became evident, the apparently inferior method was dropped and the study terminated.

During these two years 254 cases had been so assigned in alternation to the two forms of therapy. The groups were not, however, of exactly equal size. When the study ended, there was one more case in Group A than in Group B in each stage. Furthermore, 2 of the cancers of the cervical stump in Group B had been treated with vaginal cones instead of needles because of concern over anatomical relationships after hysterectomy. Thus there were 131 cases in Group A and 123 in Group B.

From these original groups, other subtractions had to be made. One case in Group A and 3 cases in Group B never returned to the hospital for treatment after their initial visit. Twelve cases in each group had roentgen therapy, but never had any application of radium. One case in Group A and 2 in Group B were proved later to have primary adenocarcinoma of the corpus, and were transferred to that classification. Four Group A cases, on account of the local anatomy of the lesion, were treated by the insertion of parametrial

needles. Twelve cases who were scheduled to have parametrial needles inserted never had this done. Eight of these were near the end of our series when we had become convinced of the high degree of morbidity induced by needles and were, in consequence, somewhat loath to use them.

If, then, we count only those cases of cancer of the cervix which received external divided dose roentgen therapy and some form of intracervical radium, we find that 113 cases were treated with intravaginal cones and 94 by the insertion of parametrial needles (see Table I).

TABLE I

	Group A	Group B
No treatment at Memorial Hospital	1	3
No radium used	12	12
Later diagnosis adenocarcinoma of the corpus	1	2
Group A cases treated with needles	4	—
Group B cases treated without needles	—	12
	18	29
Suitable cases	113	94
	131	123

IRRADIATION TECHNIQUES

The patients in Group A were treated by divided dose external roentgen therapy and through the vaginal cones pictures in Figure 1. These cones were made of brass and lined with lead and fitted into a master cone attached to the 120 kv. low voltage therapy machine, which was completely shock-proof. The distance from the target to the end of the cone was 35 cm. The filtration was 3 mm. aluminum. Accurate direction of the roentgen-ray beam was secured only after considerable experience. With the patient's legs in stirrups, the cone was inserted by means of an obturator which closed its vaginal end. The obturator was then removed and the field of irradiation

observed by looking through the cone with suitable illumination. The machine was then lowered into position to engage the end of the cone without changing its position.

one directly to the cervix and one to each vaginal vault, were usually possible. Typically, the cervix received four treatments of 500 r at a treatment (measured in air) for a total dose of 2,000 r. The parametrial

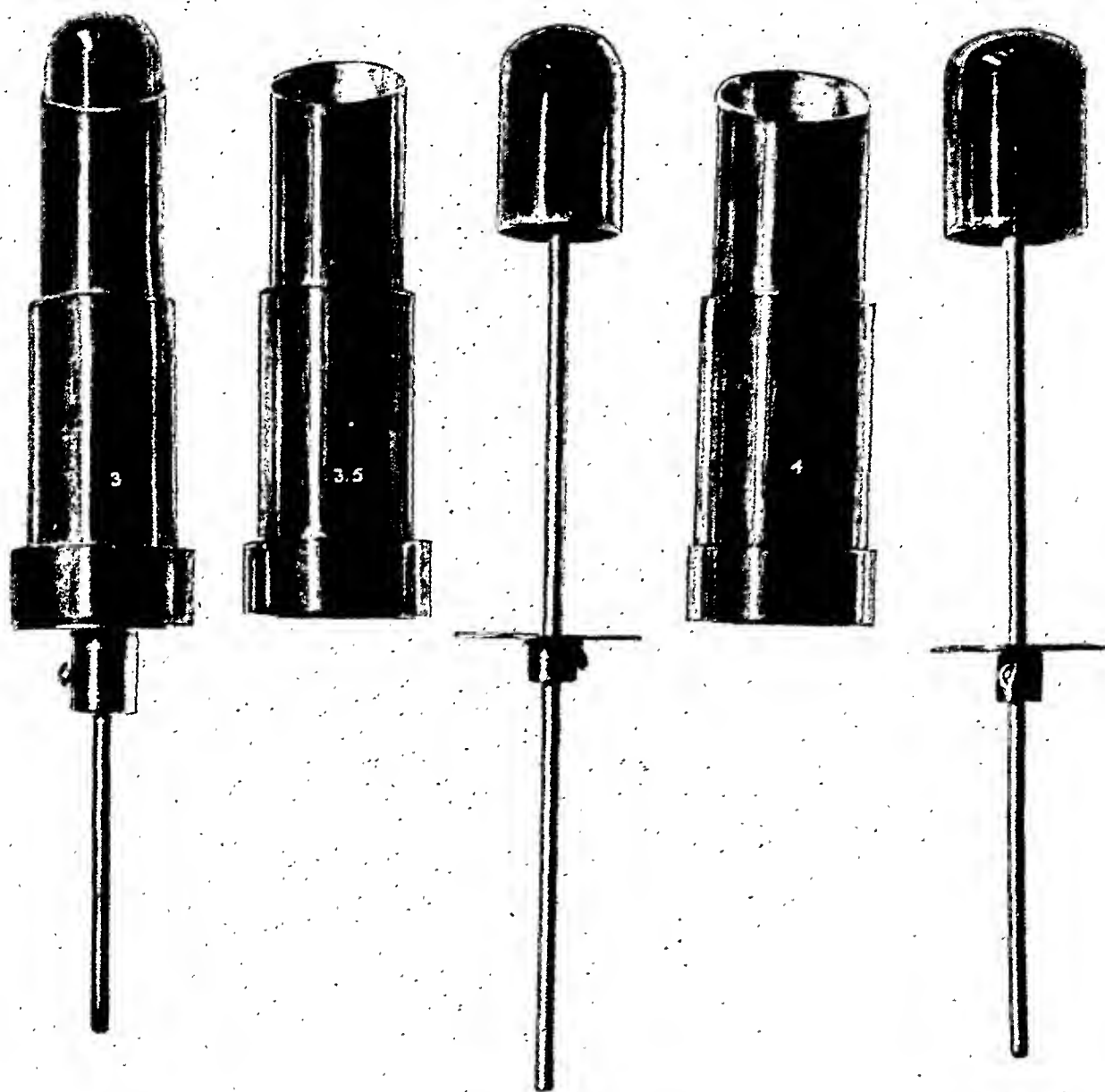


FIG. 1. Three sizes of intravaginal cones used in treating cancer of the cervix. These cones fit a master cone on the 120 kv. shock-proof roentgen therapy machine. The obturators used in introducing the cones are shown alongside of them, except with the 3 cm. size, into which the obturator has been inserted.

In the typical plan of irradiation, the intravaginal therapy was given three times a week during the course of external roentgen irradiation and before the application of radium to the cervix. With the 3 or 4 cm. cone, three fields of vaginal irradiation,

treatments of 750 r each were given through a 3 cm. cone pointed into each vault. For this purpose the cone was directed at an angle of 30 degrees from the long axis of the body, an attempt being made to get the end of the cone into the fornix lateral to

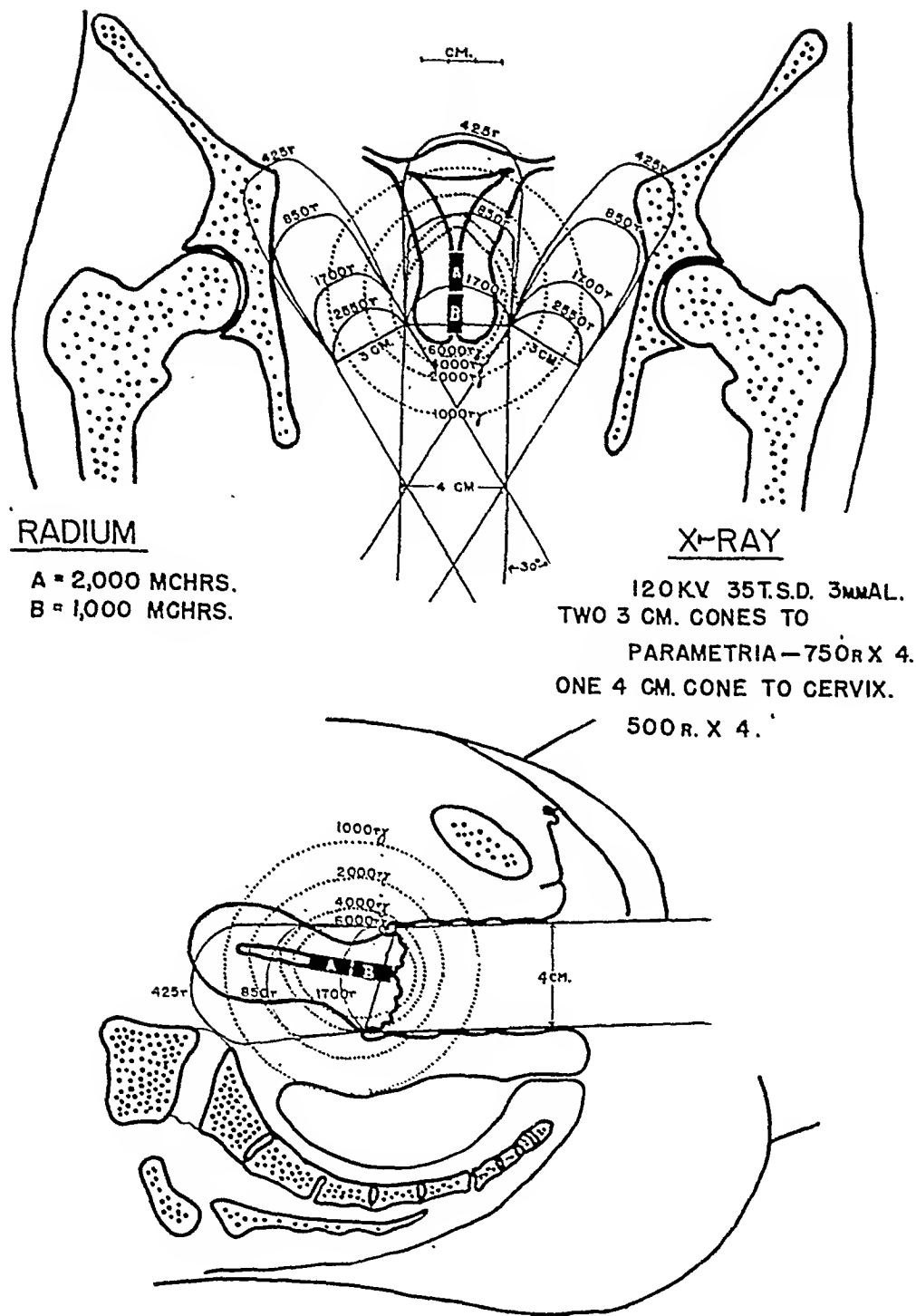


FIG. 2. Diagrammatic representation of the method of treatment and dosage used for treatment of cancer of the cervix with intravaginal cones. The dotted lines show tissue gamma roentgens (r_r) delivered by the intracervical radium. One thousand gamma roentgens are approximately equal to 1 threshold erythema dose. The solid isodose lines show doses delivered by the intravaginal cones. Four hundred twenty-five roentgens is approximately 1 threshold erythema dose.

the cervix. Each fornix was treated four times, giving a total dose of 3,000 r (Fig. 2).

It was found very shortly that patients who were receiving intravaginal cone treatments were developing rather severe rectal

symptoms, diarrhea, tenesmus and pain. These symptoms did not occur in such troublesome fashion when care was taken to have the vaginal cone almost horizontal so that it pointed to the promontory of the

sacrum or even anterior to it, rather than in the normal axis of the vagina. A small pillow under the patient's buttocks helped to straighten the direction of the vaginal canal. The patients were instructed to empty the bowel every morning before they came to the hospital for treatment, using a glycerine suppository if necessary.

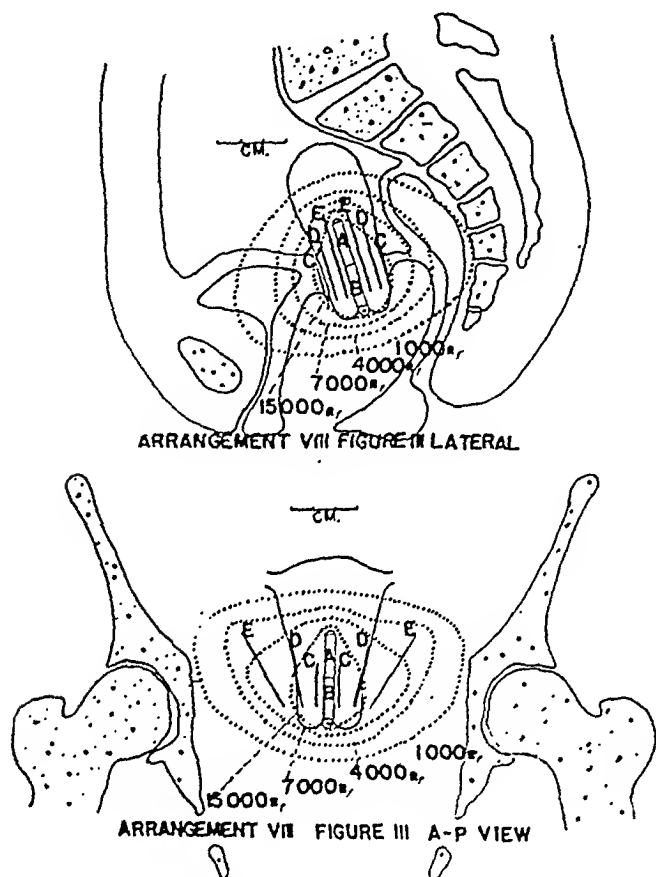


FIG. 3. Arrangement of radium capsules and parametrial needles used in this investigation. Dotted lines show tissue gamma roentgens, 1,000 r, being approximately 1 threshold erythema dose. (Reproduced by permission from Nolan and Quimby,⁹ *Radiology*, 1943, 40, 391-402.)

This description is obviously that of an ideal treatment. Some women had narrow vaginas and had to receive all their treatments through a small cone. In some cases the vault of the vagina was narrow and the fields of necessity overlapped. In some cases it was hard to angle the cone laterally as much as was desirable. Frequently the cone was adjusted to treat an area of carcinomatous extension which could be easily palpated. On account of difficulties in making appointments for the one machine avail-

able, some patients had to have the intravaginal treatments after the rest of the external roentgen therapy had been finished.

Two weeks after completion of all roentgen therapy the patient was admitted to the hospital and a radium applicator was inserted into the cervical canal under pentothal anesthesia, for a dose of 3,000 mc-hr.

The patients in Group B who were to receive parametrial radon needles started their therapy with external roentgen irradiation, receiving ten treatments of 200 r each to each of six pelvic fields with the 200 kv. or 250 kv. machine. Two weeks after the last treatment they were admitted to the hospital for radium. The radium application was made according to the plan outlined by Nolan and Quimby,⁹ who had carried out a special study of the distribution of radiation from various combinations of needles and tandems in the physics department of the Hospital just before our present study was begun. Their plan was a slight modification of that used by Pitts and Waterman. The principal change was the use of a two capsule tandem, with the lower capsule twice as strong as the upper one, in place of their 4 cm. cervical applicator of uniform strength. They also recommended that the four needles inserted into the cervical tissue be 2 cm. in active length rather than 3 cm.

The actual procedure began with the exposure of the cervix with suitable retractors and a slight dilation of the cervical canal. Four steel sheath needles containing radon gas in gold tubes 2 cm. in active length were then inserted into the periphery of the cervix, two in front and two in back, the needles of each pair being separated from each other by about 1 cm. Lateral to each of the first needles and separated from it by about 1 cm. was placed another needle, four in all, having an active length of 3 cm. These were angled out slightly toward the parametria. Finally four needles of 4 cm. active length were inserted, two into each side, at a distance from each other and the neighboring 3 cm. needles of about 1 cm.

and directed into the parametrium at an angle of about 30 degrees. This arrangement is illustrated by Nolan and Quimby's diagram (Fig. 3).

After the needles had been inserted, a radon tandem approximately the length of the cervical canal and containing about the same amount of radon as was present in all the needles combined was slipped between the vaginal ends of the needles into the canal, and it and the needles packed in carefully with long strips of 2 inch gauze

RESULTS

This report is not based on the usually accepted five year follow-up, and is, therefore, in one sense a progress report of an experiment already done, but whose final results are not yet complete. The patients whom we are reporting were first seen and their treatment begun in the years 1943-1944. Follow-up data are available on these cases for periods ranging from nine to thirty-four months, the average being 19.6

TABLE II

	Group A						Group B					
	Stage I	Stage II	Stage III	Stage IV	Cervical Stump	Totals	Stage I	Stage II	Stage III	Stage IV	Cervical Stump	Totals
Alive without disease	20	23	4	0	7	54	10	14	1	0	1	26
Alive with cancer	2	3	3	0	1	9	0	6	0	0	1	7
Alive with ? cancer	0	3	1	0	0	4	1	1	1	0	1	4
Dead with cancer	2	9	17	5	2	35	4	16	14	1	4	39
Dead without cancer	0	1	0	0	0	1	1	0	0	0	0	1
Dead with ? cancer	0	2	0	0	1	3	1	5	3	1	2	12
Lost	0	2	4	0	1	7	2	3	0	0	0	5
Total	24	43	29	5	12	113	19	45	19	2	9	94

packing. This packing was used not only to keep the needles and tandem in place, but to distend the vagina and keep the rectum and bladder base as far away as possible from the radium. The patient's bladder was kept empty by an indwelling catheter.

The radium was left in place until a total dose of 6,000 mc-hr., approximately 3,000 from the needles and 3,000 from the tandem, had been delivered. Since radon was used, the strength of the applicators varied. In general, the needles altogether averaged about 100 mc. in strength, with the cervical tandem amounting to another 100 mc. Some needles, however, were as weak as 60 mc. and some as strong as 212 mc. Thus the time of treatment varied from twelve to fifty hours, the average being about thirty hours.

months. However, since the patients were so carefully alternated between our two groups, the data we are able to present now have considerable significance in contrasting the value of these two particular techniques.

Of 113 cases in Group A treated with vaginal cones, 54, or 47.8 per cent, were alive and free of cancer when last examined before the statistics were compiled. Of the 94 cases in Group B treated with parametrial needles, 26, or 27.7 per cent, were alive and free of cancer. In Group A, 39 were dead, or 34.5 per cent. In Group B, 52, or 53.3 per cent. In Group A, 67 were alive, 9 with cancer and 4 possibly with cancer, or 59.3 per cent; in Group B, 37 were alive, 7 with cancer and 4 possibly with cancer, 39.4 per cent.

Not only was the total number of pa-

tients alive or alive without evidence of cancer greater in the group treated with cones, but this was uniformly true in all stages of the disease (see Table II). In particular it was interesting to note that in Stages II and III, where the parametria were involved with cancer, the results with needles were inferior.

In addition to the higher expectancy of life, the group treated by vaginal cones enjoyed the advantage of fewer complications of treatment. The complications occurring with each form of therapy are listed in Table III.

TABLE III
MORBIDITY—COMPLICATIONS

	Group A (Cones)	Group B (Needles)
Diarrhea	10	33
Rectal bleeding	11	24
Rectal stricture	7	18
Rectal fistula	5	12
Local necrosis (cervix or vaginal vault)	50	63
Vaginal hemorrhage	17	27
Genitourinary symptoms	23	33
Pain (excessive or noted on chart)	51	63

Perhaps the most marked contrast is to be found in the occurrence of rectal symptoms. Among the patients treated with interstitial needles, 33 complained of troublesome diarrhea, 24 of rectal bleeding, 18 developed rectal strictures and 12 fistulas. Of these last, 9 were patients classified as Stages I and II; in other words, the fistula was due to irradiation injury of the rectal wall and not to destruction of cancerous tissue which had already invaded the rectum. In the cases treated with vaginal cones, only 10 complained of diarrhea, 11 of bleeding, 7 developed strictures and 5 fistulas. Three of these latter were in advanced cases, Stages III and IV.

Perhaps the explanation of the more frequent rectal symptoms in patients treated with needles is to be found in the difficulty of determining the position of the parametria from vaginal examination. A private

patient, not one of the present series, was operated upon for the purpose of removing the pelvic lymph nodes, as advocated by Taussig,¹² immediately after the insertion of the parametrial needles. Figure 4 shows the posterior cul-de-sac as seen through the laparotomy wound, with substantial portions of each of five of the needles easily visible. In addition, the two 3 cm. needles on the left side could be seen and felt but do not show in the photograph. The second 4 cm. needle on the left lay between the uterine artery and the ureter. It seems probable that needles, 3 or 4 cm. in length, placed according to the technique described, will often pierce the thin bases of the uninvolved broad ligaments and so come to lie alongside the rectal wall.

The criticism might be made that the needles were inserted too much toward the rectum, but the frequency of bladder symptoms seems to preclude any shift in an anterior direction. Thirty-three of the cases treated with needles complained of severe symptoms of bladder irritation. Five cases in Stage I and Stage II developed vesicovaginal fistulas, while none of the cases of these stages treated with vaginal cones did so. Twenty-three of the cone-treated patients did, however, complain of some symptoms of bladder irritation.

Necrosis of the tumor, cervix and vaginal vault are a striking feature in the charts of the cases treated by needles. In 63 of the 94 histories, this necrosis is mentioned specifically. Vaginal hemorrhage occurred in twenty-seven.

In the other group, the patients treated by cones, 50 of the 113 patients showed some local necrosis, but this was usually not so deep or extensive as in the needle cases. Seventeen patients of the cone group experienced vaginal hemorrhage.

DISCUSSION

A brief consideration may be given to possible reasons for the more favorable results obtained by other workers with the use of interstitial radium in cancer of the cervix. From illustrations published by

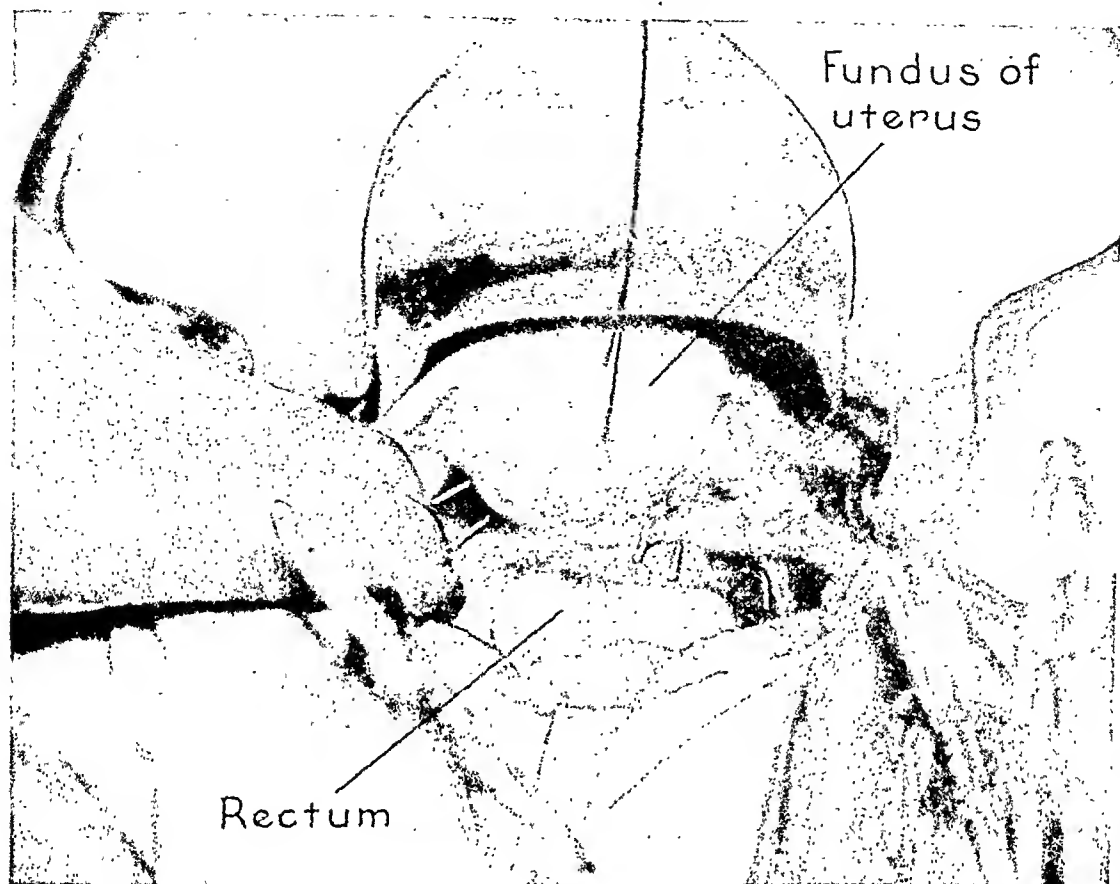


FIG. 4. This photograph was taken during a laparotomy on a patient into whose cervix needles had been inserted, as described in the text. The ends of five parametrial needles projecting into the posterior cul-de-sac are easily seen. Were the fundus of the uterus not pulled forward by a suture, it is readily understood that these needles would lie in close apposition to the anterior rectal wall.

Pitts and Waterman,¹⁰ it appears that they tended to keep the needles in closer to the corpus of the uterus than we did. Their needles have a wall thickness of 0.5 mm. of platinum, while we were using steel needles with radon-filled gold tubes inside them with a wall thickness of 0.3 mm. Pitts and Waterman left their needles in place for 168 hours, while in our cases the intensity was greater and the time consequently shorter, fifteen to fifty hours. Thus differences in results might be due to many factors; namely, to the distribution of radium, the filtration, the intensity of radiation, or the experience of the surgical personnel. That the method is not without complications even in the hands of Pitts and Waterman is shown by a reported incidence of 38 fistulas in 480 cases, or 7.9 per cent. Our cone-treated cases showed 7 fistulas in 113 cases, or 6.1 per cent.

It is not intended to advocate the use of vaginal cones as superior to any other

method of irradiation in cancer of the cervix. These cases have been followed for much too short a time for us to have any opinion as to whether the ultimate cure rate will be better than it has been with the past technique employed by the Hospital which was based on the divided dose roentgen therapy, vaginal radon bomb, and cervical tandem. By *a priori* reasoning, the use of cones would be expected to give good results, for they deliver uniform radiation in fairly large doses into the parametria at a depth from the vagina more successfully than any other method.

This paper is simply a progress report describing preliminary results obtained by treating comparable groups of cases by two methods thought at the start to be equally effective. In our experience, using our particular radon needles, parametrial interstitial irradiation has proved to be more dangerous to the patient and not so effective in curing the cervical cancer as the

treatment of the parametria with vaginal cones.

SUMMARY

1. During the years 1943 and 1944 all primary cases of cancer of the cervix coming to the gynecological clinic of the Memorial Hospital were divided into two equal and comparable groups.

2. One group was treated with divided dose roentgen therapy to the pelvis and intravaginal roentgen therapy to the parametria and cervix through special cones. This program of roentgen therapy was followed by intracervical radium. The second group also received divided dose external roentgen therapy and intracervical radium, but the intravaginal roentgen treatments were replaced by interstitial radon therapy delivered by means of needles inserted into the parametria at the time the radium was applied to the cervical canal.

3. At the present time, from nine to thirty-four months after treatment was begun, 54 of 113 cases (or 48 per cent) treated with intravaginal cones are alive and apparently free of cancer; 39 (or 34.5 per cent) are dead. Twenty-six of 94 cases (or 28 per cent) treated with interstitial needles are alive and apparently free of cancer; 52 (or 53 per cent) are dead.

4. The patients treated with needles had more severe rectal symptoms (diarrhea, bleeding, stricture and fistula), more bladder symptoms (dysuria, frequency, hematuria and fistula), and more local necrosis, hemorrhage and pain than did those treated with vaginal cones.

5. We have concluded that *in our experience* the use of interstitial radon needles is relatively ineffective and dangerous as a method of controlling cervical cancer and we have abandoned it in favor of intravaginal and external roentgen therapy combined with intracervical radium. The final results of this type of treatment are, however, not yet known.

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REFERENCES

1. ALLEN, C. W. Radiotherapy and Phototherapy. Lea Brothers & Co., Philadelphia, 1904, pp. 194-197.
2. ARNESON, A. N., and HAUPTMAN, H. Radium needles in treatment of cancer of cervix and vagina. *South. M. J.*, 1940, 33, 286-293.
3. Atlas Illustrating the Division of Cancer of the Uterine Cervix into Four Stages According to the Anatomical and Clinical Extent of the Growth. League of Nations Health Organization. P. A. Norstedt and Sons, Stockholm, 1938.
4. ERSKINE, A. W. Evolution of an improved transvaginal speculum. *Radiology*, 1944, 43, 170-174.
5. HEALY, W. P., and TWOMBLY, G. H. Cancer of cervix; effect on rate of cure of increased roentgen radiation to the parametria. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 49, 519-530.
6. MARTIUS, H. Die intravaginale Röntgenbestrahlung, ihre Entwicklung und Bedeutung. *Arch. f. Gynäk.*, 1942, 173, 97-104.
7. MARTIUS, H., and WITTE, E. Ueber einige Fortschritte im Bau und in der Anwendung des Körperköhlenrohres. *Strahlentherapie*, 1941, 69, 29-34.
8. MERRITT, E. A. Roentgen therapy of cancer in buccal cavity and of cervix uteri. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1939, 42, 418-422.
9. NOLAN, J. F., and QUIMBY, E. H. Dosage calculation for various combinations of parametrial needles and intracervical tandems. *Radiology*, 1943, 40, 391-402.
10. PITTS, H. C., and WATERMAN, G. B. Treatment of cancer of cervix uteri at Rhode Island Hospital. *Surg., Gynec. & Obst.*, 1937, 64, 30-38.
11. PITTS, H. C., and WATERMAN, G. W. Further report on radium treatment of carcinoma of cervix uteri. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 43, 567-576.
12. TAUSSIG, F. J. Iliac lymphadenectomy for group II cancer of cervix. *Am. J. Obst. & Gynec.*, 1943, 45, 733-748.
13. TEAHAN, R. W., WAMMOCK, H., and WEATHERWAX, J. Treatment of carcinoma of cervix with interstitial radiation. *J.A.M.A.*, 1942, 120, 423-426.
14. WASSON, W. W. Intravaginal roentgen irradiation of cancer of cervix. *Radiology*, 1943, 40, 454-457.
15. WATERMAN, G. W., and DI LEONE, R. Treatment of carcinoma of cervix by interstitial radium needles at Rhode Island Hospital; supplemental report. *Am. J. Obst. & Gynec.*, 1945, 50, 482-488.

TREATMENT OF CUTANEOUS HEMANGIOMA WITH RADIUM*

By EDUARDO CACERES, M.D.

LIMA, PERU

BY THE term hemangioma we mean vascular, congenital tumors occurring in the skin, subcutaneous tissues, or other structures. They form the most frequent group of tumors occurring in childhood.

MacKee² divides hemangiomas of the skin into capillary and cavernous types.

The capillary hemangioma is divided into (a) the nevus flammeus or simple variety (port wine mark), composed of a network of small capillaries without marked cellular proliferation; and (b) the nevus vasculosus (strawberry mark), a more active growth which produces upon the skin soft, elevated nodules.

The cavernous hemangioma is composed of blood spaces lined by a single layer of endothelium and filled with blood or serum. However, it is not uncommon to find, especially on the face or scalp, a cavernous hemangioma in which the overlying skin is the site of a nevus vasculosus.

Hemangioma should be treated in such a manner that there is an entire disappearance of the lesion without visible scar, atrophy or telangiectasis of the skin.

In spite of the fact that hemangioma is often self-limited and may even regress spontaneously, persistent, untreated lesions in adults and rapidly spreading lesions in infants occur frequently and justify treatment as early as possible. Hemangioma is usually present at birth but in a certain number of cases may appear several days or even as late as three weeks after birth.

Generally hemangioma increases in size during infancy. The rate of growth varies, some enlarging very rapidly and others growing slowly. Growth is usually ar-

rested by the first radium treatment. The best results are obtained with small lesions. The radiosensitivity is greatest in early infancy, when the endothelial cells lining the blood spaces still retain their embryonic character. Therefore, treatment early in life gives the better cosmetic result. The scar and pigmentation which occur in some cases diminish with the years. If treatment has been given during infancy, sufficient time will have elapsed for the scar to become inconspicuous by the time a child reaches an age when he may become conscious of a physical defect. The psychological effect of a physical defect upon a child must not be ignored.

Therefore, radium treatment should be given preferably during the first six months of life. A rapidly growing hemangioma must be treated immediately, even during the first weeks of life. Ulceration of the hemangioma is no contraindication to radium treatment but scarring will result when the ulceration heals.

Hemangioma may be treated by one or more of the following methods: carbon dioxide snow, electrocautery, injection of sclerosing fluid, excision or some form of irradiation. Because of very satisfactory results in the treatment of cutaneous hemangioma with radium, and since this method is simple, the discussion of the technique of treatment and dosage will be limited to the various types of external radium applications: (1) filtered contact radium and (2) filtered radium at distance (mold, plaque).

Radium Applicators. For filtered contact radium, platinum tubes containing 10 mg. of radium element are used. For filtered

* From the Chicago Tumor Institute, Chicago, Illinois. Read at the second Mexican National Congress of Cancer, Guadalajara, Mexico, Feb. 3-9, 1946.

radium at distance there are two types of radium applicators generally used at the Chicago Tumor Institute: plaque and mold.

There are three different sized radium plaques to simplify the treatment of different sized lesions. The filtration of these plaques is the equivalent of 3.8 mm. of brass. The radium skin distance is 5 mm. Small blocks of cork are used to maintain this distance. For complete protection the applicator is surrounded with a 2 mm. thick

lead box. Radium tubes containing 10 or 25 mg. of radium element are employed. The amount of radium required determines the number of tubes used. Generally it is about 100 to 150 mg.

Radium mold: the material used for this purpose is dental molding compound or Columbia paste, which is made in various thicknesses, usually 5 mm. and 7 mm.

The radium mold is charged with tubes of 10 mg. of radium element filtered by 1



FIG. 1. *A*, large cavernous hemangioma in left cheek. *B*, strawberry mark on left pre-auricular area. *C* and *D*, cosmetic restoration seven months after treatment. Lesion was treated by radium plaque, two fields, 1,250 mg.-hr. each.

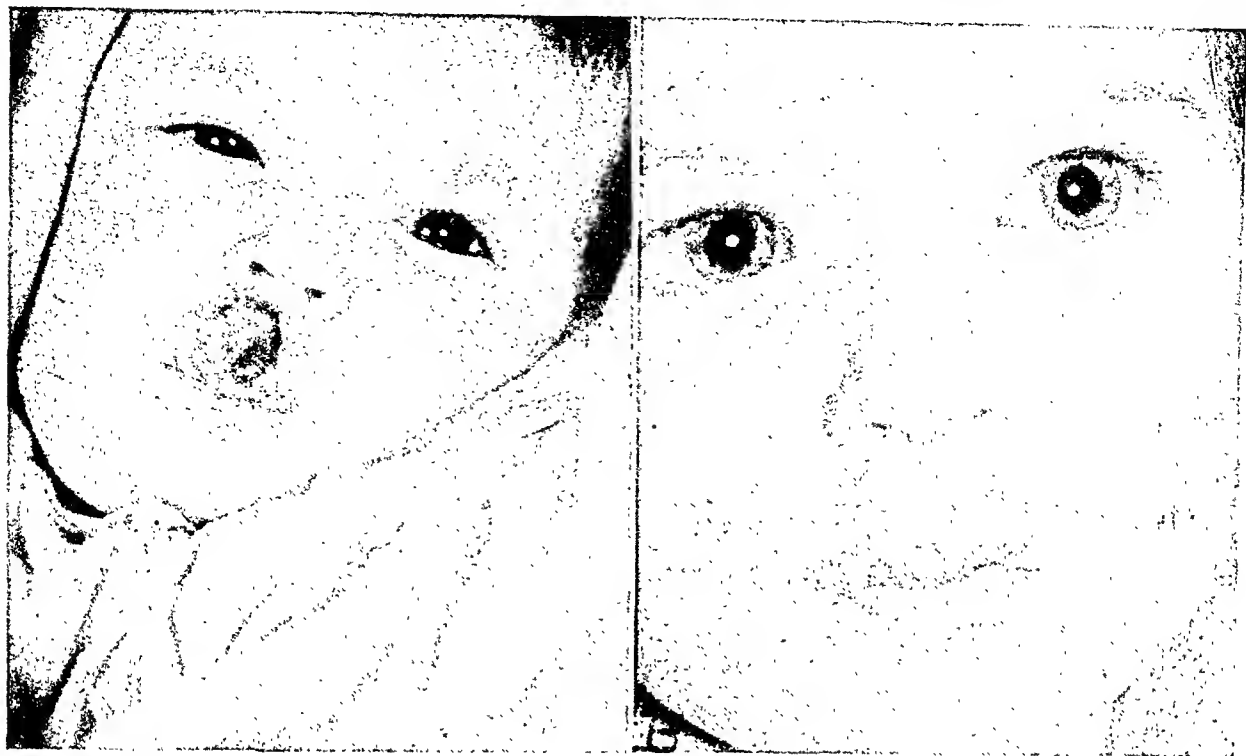


FIG. 2. *A*, cavernous hemangioma in the upper lip. *B*, results ten months after treatment. Lesion was treated by radium plaque 880 mg-hr.

mm. of platinum. It is evident that the distribution of the radium over the surface of the mold constitutes an important problem. Although it is impossible, from a practical point, to make the radiation uniform, the proper distribution can reduce the variation to a maximum of 10 per cent. The tubes, in either single or double rows, should not be equally spaced because the center would receive the greatest intensity. They should be placed closer together toward the ends of the row and farther apart in the center. In large lesions, the radium is arranged around the periphery. The number of individual problems occurring with this subject are innumerable and cannot be included in a report such as this. A complete discussion of this subject is given by Quimby.³

Selection of the Treatment. Most authors^{1,2,4} are in agreement that the simple nevus is not a suitable subject for radium or most other forms of therapy. Surgical excision is a satisfactory method for some lesions. Cosmetics may be used to cover the "port wine mark."

The "strawberry" hemangioma responds

very well to radium therapy. The lesions which are localized in the superficial layer of the dermis are best treated by contact radium therapy. A cavernous hemangioma situated in the subcutaneous tissues requires more penetrating radiation because of its greater bulk. Very large cavernous hemangiomas may require a combination of external and interstitial irradiation (removable radium needles). The necessity of using interstitial irradiation will depend upon the response to external irradiation.

The combined lesions "cavernous" and "strawberry" which frequently occur may be treated first by radium plaque. If, after the cavernous part of the hemangioma has responded, areas of skin discoloration still persist, contact radium therapy may then be used.

Very small pink lesions of the face should be treated by beta radiation. When the lesion is in a difficult position for a good application of a plaque or when the surface area of the lesion is greater than the area of standard applicators, mold applicators are used. Very extensive hemangiomas may be divided into several fields and

the various areas treated at intervals of one week. A margin of 3 or 4 mm. must be left between the treatment fields to avoid overlapping or excessive reaction.

Technique of Application. 1. Contact radium therapy: the radium tubes are fixed by cellulose adhesive tape, a transparent material which permits complete visualization of the lesion and the radium tube.

2. Molds generally are fixed to the skin by adhesive tape but may be fastened by tapes through small holes in the mold.

3. The plaques are fixed by adhesive tape or bandages. Great care must be given

to the adjustment of the applicator so that it does not slip. The size of the applicator must be 3 to 4 mm. greater than the lesion. If the hemangioma is prominent, slight compression with the applicator is advantageous. During the course of irradiation the positioning should be checked frequently.

Dosage. In the United States the dosage is generally expressed in terms of milligram-hours or millicurie-hours. It is computed by multiplying the number of milligrams of radium or millicuries of radium emanation utilized, by duration in hours of

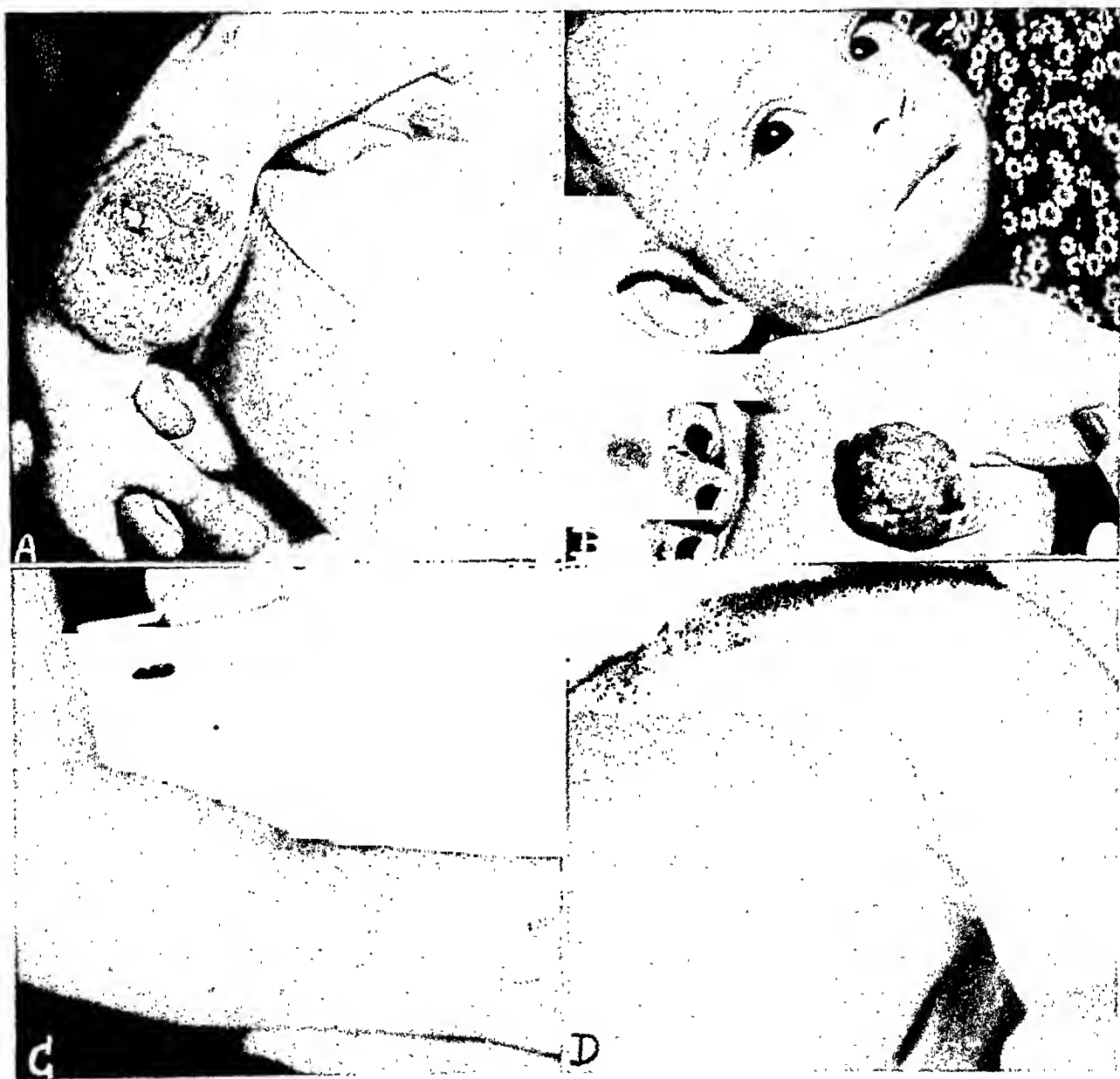


FIG. 3. *A*, ulcerated cavernous hemangioma of the right forearm. *B*, large cavernous hemangioma of the right scapular area. *C* and *D*, condition two and a half years after treatment by radium plaque, two fields, 800 mg-hr. each.

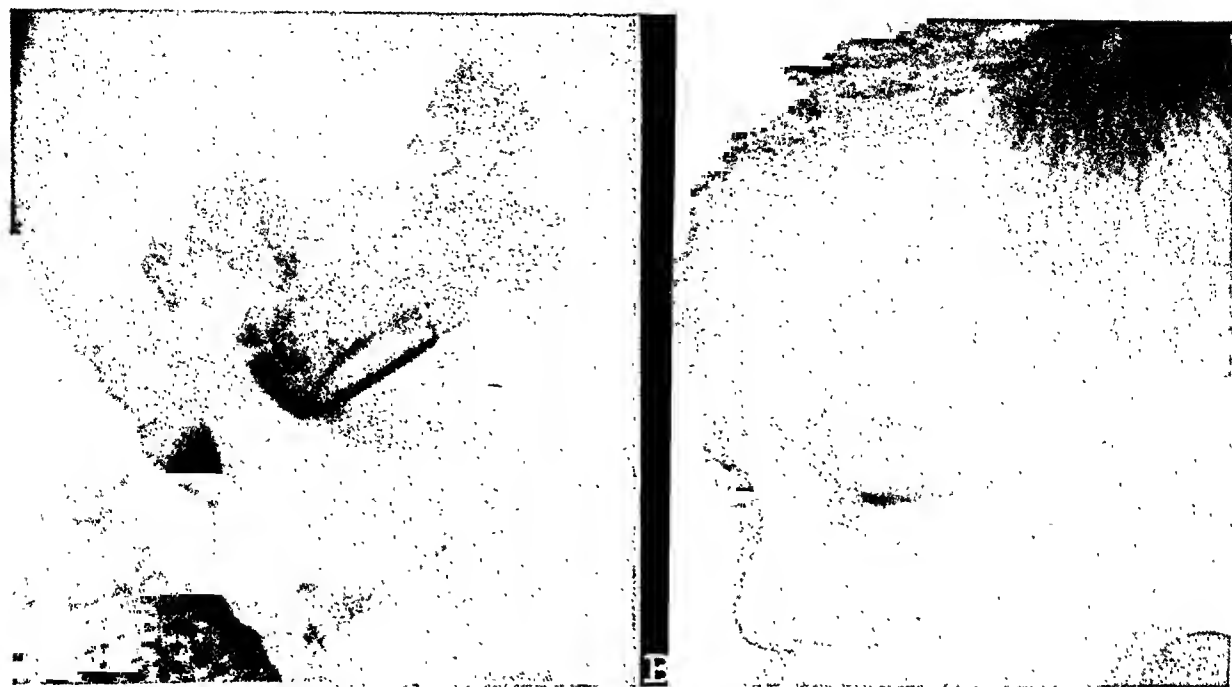


FIG. 4. *A*, cavernous hemangioma of the left eyelid, forehead and temporal region. *B*, result two years and nine months after treatment. Radium plaque, two fields, 620 mg-hr. each.

the application. When unfiltered radium is used, the dose is measured by milligram-minutes. Elsewhere the French measurements are followed; this is computed by the quantity of radium destroyed during the course of application. The advantage of this method is that the same measuring factor is applicable to tubes of radium or of radon. One millicurie-destroyed is the equivalent of 133 milligram-hours or of 133 millicurie-hours. One milligram-hour is equivalent to 7.55 microcuries-destroyed. Either of the methods fails to consider the energy produced and measures only the source of the radiation like measurement of roentgen rays in kilovolt-hours and milliamperes-minutes. Radium dose expressed in roentgens is probably the most accurate.

When determining the dose to be used, the minimal quantity of radiation which appears to affect the vascular tumor should be employed. The dose should be low enough to avoid skin reaction.

Since the sensitivity of the skin varies with age, location and condition, dosage is a matter of experience and it is not possible to make rigid standards. The dosage will depend on many factors: distance from the

skin surface of the area treated, strength of the applicator, and the character of radiation (beta or gamma). In the treatment of hemangioma the single dose is more important than the total dose. The suberythema dose should never be exceeded. The total dose is determined by the response of the hemangioma to the treatment.

In the series treated with radium plaque in all the cases but one the individual total dose for a single field did not exceed 800 mg-hr. The single dose usually was 100 mg-hr.

In contact radium therapy 10 mg. tubes of radium are employed, the size of the lesion determining the number of tubes. For small lesions, where one or two tubes are sufficient to cover the lesion, 10 to 20 mg-hr. is the usual single dose. Where 3, 4 or 5 tubes are used, a single dose of 25 to 40 mg-hr. must not be exceeded. The total dose in the series was between 120 and 185 mg-hr.

For beta radiation therapy, a 25 mg. radium tube, filtered by 0.2 mm. of monel, is used. A dose of 75 to 100 milligram-minutes is not exceeded.

Intervals Between Treatments. The special

sensitivity of children's tissues should enter into consideration when determining the interval between treatments. These should be spaced to avoid injurious accumulation. Routinely treatments are given every three or four weeks although in certain cases they can be given every week. If there has been intense erythema the next treatment should be delayed for two weeks or until the reaction has subsided. Usually after three or four treatments, if the lesion has regressed sufficiently, the interval should be increased to two or three months. This may avoid overtreatment.

ANALYSIS AND RESULTS

The following is an analysis of the results in 66 cases of hemangioma treated in the Chicago Tumor Institute:

Sixty-nine per cent of our cases were referred for treatment during the first year of life. In 7 cases the treatment was given before two months of age. The ratio between females and males is 2 to 1. In 46 per cent the lesions were found on the head and neck. Twenty-nine per cent had multiple hemangiomas. Several children had as many as four lesions.

In evaluating the results of treatment, we have considered as "excellent" those where the site of the hemangioma cannot be detected, and those in which the results have not been so perfect but the size and state of the covering skin permit us to

consider it as such; as "satisfactory" those where some discoloration or scarring remained; as "failure" those which did not respond sufficiently to be included in the other groups.

Of the 66 unselected cases of hemangioma treated at the Chicago Tumor Institute 49 (74 per cent) may be classified as excellent, 13 (20 per cent) as satisfactory and 4 (6 per cent) as failures.

SUMMARY

Radium treatment of cutaneous hemangioma is discussed, selection of treatment, dosage and the technique of radium therapy being presented in detail. Statistics regarding age, sex, distribution and end results are reported.

I am indebted to Dr. Esther Marting for her helpful comments during the development of this paper.

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REFERENCES

1. MACCOLLUM, D. W. Treatment of hemangiomas. *Am. J. Surg.*, 1935, 29, 32-35.
2. MACKEE, G. M. X-rays and Radium in the Treatment of Diseases of the Skin. Lea & Febiger, Philadelphia, 1921, p. 485.
3. QUIMBY, E. H. Grouping of radium tubes in packs or plaques to produce the desired distribution of radiation. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1932, 27, 18-39.
4. SCHAMBERG, J. F., and BRADLEY, R. A. Radium in treatment of angiomas. *Surg. Clin. North America*, 1927, 7, 103-111.



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E D I T O R I A L S

THE ANNUAL MEETING

THE Forty-seventh Annual Meeting of the American Roentgen Ray Society which was held at the Netherland Plaza in Cincinnati, Ohio, September 17 to 20, 1946, was marvelously well attended, there being over a thousand people in attendance. The mere presence of numbers, however, does not in itself indicate the quality of the meeting, but the enthusiasm of the members of the Society and their guests for the scientific program was evidenced by the attendance at the scientific sessions, and President Beeler and his committee may be congratulated upon the versatile and comprehensive program which was arranged. This being the first post-war meeting of the Society added greatly to its interest. It was nice once again to have the privilege of seeing old friends and making new acquaintances, which in itself is no small contribution to the success of a meeting. For perhaps one of the most pleasant aspects of any annual meeting is the exchange of ideas in conversation outside the scientific meeting room.

This year's Caldwell Lecture which was given by Dr. Andrew Conway Ivy, Nathan Smith Davis Professor of Physiology, Northwestern University Medical School, on "Motor Dysfunction of the Biliary Tract: An Analytical and Critical Consideration" was one of the highlights of the meeting. Dr. Ivy, who has devoted years to research on the gastrointestinal tract as well as the biliary tract, discussed the problems relating to the normal as well as the pathologic function of the gallbladder and its tract, relating the known facts and putting into bold relief many of the unsolved problems concerning the biliary tract in which roentgenological studies themselves might be of considerable aid in their elucidation.

Indeed the entire program was of such a nature as to appeal to all those interested

in scientific developments and advancements of roentgenology.

Then, too, the members of the Society and their guests had the privilege of once again viewing the technical advances which had been made in roentgen apparatus, drugs, etc., in the intervening years since the former annual meetings. These exhibits were displayed in the Hall of Mirrors and in the adjoining rooms.

Dr. Donaldson, the Chairman of the Scientific Exhibits and his committee arranged a splendid exhibit which was one of the important functions of the meeting and attracted an unusual amount of interest and favorable comment. A brief description of the scientific exhibits is given elsewhere in this issue of the JOURNAL.

The social aspects of the meeting which were arranged by Dr. Reineke and his local committee were all that one could anticipate for nowhere are the social aspects of a meeting more enjoyed than in Cincinnati which has always set a very high standard of entertainment. Particularly is the Ladies' Entertainment Program Committee to be congratulated and thanked for the fine entertainment which they arranged for the wives of the members and their guests. The annual golf tournament was well attended and the competition for the Willis F. Manges Trophy was keen.

Dr. Kirklin, the Director of the Instructional Courses, reports an unusual interest in these courses, all of which were well attended, and the arrangement of the program was such that full attendance at the Instructional Courses was possible.

It may be said in passing that no hotel in which the Society has convened has offered better facilities for the meeting than the Netherland Plaza, and to the personnel of the hotel the Society offers its thanks for their cooperation in making the 1946 annual meeting the success which was anticipated.



WALTER SIBLEY LAWRENCE
1867-1946

WALTER SIBLEY LAWRENCE died on July 6, 1946, at his home, 1622 Central Avenue, Memphis, Tennessee, from cardiac failure, after an illness of almost two years.

Dr. Lawrence, a member of the American Roentgen Ray Society since 1917, was born

July 28, 1867, in Cambridge, England. His parents were the Reverend J. P. Lawrence, an Episcopal clergyman, and Amelia Sibley Lawrence. His father held a ministry in Staunton, Virginia, where Dr. Lawrence spent his childhood after the age of twelve. After attending the University of Virginia,

Dr. Lawrence transferred to the University of Tennessee, receiving the degree of B.S. in 1891. In 1900 he received his M.D. degree from Vanderbilt University. Shortly after beginning practice in Memphis, he became interested in radiology, and for twenty-five years before his death he was Professor of Radiology at the Medical School of the University of Tennessee. His principal interest was in radiation therapy.

He was married on April 5, 1910, to Miss

Merle Mauldin, who survives him. He leaves also a daughter, Mrs. Reid Bondurant of Memphis, and two grandchildren, three sisters and one brother. He was a communicant of Grace-St. Luke's Episcopal Church.

In addition to be a golfer and a gardener, Dr. Lawrence wrote poetry. His friends look forward to a compilation of his verse, contemplated by one of his sisters.

RAMSAY SPILLMAN



SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: 1947, to be announced.

AMERICAN COLLEGE OF RADIOLOGY

Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1947, to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: 1947, to be announced.

AMERICAN RADIUM SOCIETY

Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: 1947, to be announced.

ARKANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Palmer House, Chicago, Ill., Dec. 1-6, 1946.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

RADIOLOGICAL SECTION, LOS ANGELES CO. MED. ASSN.

Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. Roy G. Giles, Temple, Texas.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. A. H. Levy, 1354¹ Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. F. H. Squire, 1754 W. Congress St., Chicago 12, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. Carroll C. Dundon, 11311 Shaker Blvd., Cleveland, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB

Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DENVER RADIOLOGICAL CLUB

Secretary, Dr. W. C. Huyler, 1619 Milwaukee, Denver 6, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Dell, Jr., 333 W. Main St., S., Gainesville, Fla. Meetings in May and November.

GEORGIA RADIOLOGICAL SOCIETY

Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

RADIOLOGICAL SOCIETY OF KANSAS CITY

Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

IOWA X-RAY CLUB

Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KENTUCKY RADIOLOGICAL SOCIETY

Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY

Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

LOUISIANA RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. Annette T. Stenstrom, 1218 Medical Arts Bldg., Minneapolis, Minn. One meeting a year at time of Minnesota State Medical Association.

NEBRASKA RADIOLOGICAL SOCIETY

Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Neb. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library

NEW HAMPSHIRE ROENTGEN RAY SOCIETY

Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

RADIOLOGICAL SOCIETY OF NEW JERSEY

Secretary, Dr. W. H. Seward, Orange Memorial Hospital, Orange, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY

Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY

Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

CENTRAL NEW YORK ROENTGEN RA SOCIETY

Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year, January, May, November.

OHIO RADIOLOGICAL SOCIETY

Secretary, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

ORLEANS PARISH RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC ROENTGEN SOCIETY

Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. C. L. Stewart, Jefferson Hospital. Meets first Thursday of each month, October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY

Secretary, Dr. L. M. J. Freedman, 115 South Highland Ave. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

PORTLAND ROENTGEN CLUB

Secretary, Dr. Selma Hyman, University of Oregon Medical School, Portland, Oregon. Meets monthly 2d Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Secretary, Dr. A. M. Popma, 220 N. First St., Boise, Idaho.

ST. LOUIS SOCIETY OF RADIOLOGISTS

Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY

Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

SAN FRANCISCO RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph Levitin, 516 Sutter St., San Francisco 2, Calif. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

SHREVEPORT RADIOLOGICAL CLUB

Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.

UTAH RADIOLOGICAL CONFERENCE

Secretary, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

UTAH STATE RADIOLOGICAL SOCIETY

Secretary, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

VIRGINIA RADIOLOGICAL SOCIETY

Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO

Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA

General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE ROENTGEN SOCIETY

Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

FACULTY OF RADIOLOGISTS

Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

CANADIAN ASSOCIATION OF RADIOLOGISTS

Secretary, Dr. J. W. McKay, 1620 Cedar Ave., Montreal.

SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES

Secretary, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

SOUTH AMERICA

SOCIEDAD ARGENTINA DE RADIOLOGIA

Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDAD PERUANA DE RADIOLOGIA

Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

CONTINENTAL EUROPE

CESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE

Secretary: MUDr. Roman Blána, Praha XII, Kofunčí 160, Czechoslovakia.

SOCIEDAD ESPAÑOLA DE RADIOLOGIA Y ELECTROLOGIA

Secretary, Dr. J. Martín-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

Secretary for French language, Dr. Babaianz, Geneva. *Secretary* for German language, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banual Măracine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY

Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

SCIENTIFIC EXHIBIT

The Scientific Exhibit at the Forty-seventh Annual Meeting of the American Roentgen Ray Society held at the Netherland Plaza, Cincinnati, Ohio, September 17-20, 1946, was, as always, one of the most instructive features of the meeting and was arranged by the Chairman of the Scientific Exhibits, Dr. S. W. Donaldson, and his Committee. A description of the exhibits, with awards given, follows:

An exhibit entitled "The Roentgenologic Contribution to the Diagnosis of Meckel's Diverticulum" was presented by Drs. H. M. Weber and C. A. Good, Jr., Mayo Foundation for Medical Education and Research, Rochester, Minn. Meckel's divertic-

ulum has been called the most common congenital anomaly of the intestinal tract. The roentgenologic examination can be made to exhibit Meckel's diverticulum as such in a certain percentage of cases but its chief contribution to the diagnosis of Meckel's diverticulum is in ruling out other lesions of the small intestine which produce the same symptoms and signs. The exhibit illustrated by roentgenograms the experience of the Section on Roentgenology at the Mayo Clinic with the diagnosis of Meckel's diverticulum in its various manifestations. This exhibit received Honorable Mention.

The next exhibit was entitled "The Effect of Irradiation upon the Minute Blood Vessels and Lymph Flow of the Skin. A Clinical and Experimental Study." This was from the Department of Radiology and the Robinette Foundation of the Medical Clinic of the Hospital of the University of Pennsylvania, Philadelphia, Pa., and was presented by Drs. Eugene P. Pendergrass, Robert H. Ivy (by invitation), John Q. Griffith, Jr. (by invitation), Charles R. Perryman (by invitation), Stuart P. Barden (by invitation), Philip J. Hodes, and Robert P. Barden. The exhibit consisted of charts, photographs and drawings. The clinical material consisted of studies of the thigh area in human volunteers following varied roentgen dosage. Included were simple observation of the area, capillary microscopy and, after the interval of at least a year, biopsy followed by histologic study. The experimental material consisted of studies, largely with animals, describing the effect of radiation on cutaneous lymphatic flow, capillary permeability and fragility, and tendency to venous thrombosis. Comparison was made, in certain respects, between irradiation by roentgen rays and radon. The following procedures or medicaments were described and their effect on the cutaneous reaction to irradiation in animals: (1) sympathectomy; (2) experimental hyperthyroidism; (3) dicoumarin; (4) rutin. The skin changes were illustrated with beautiful color trans-

parencies. This exhibit was awarded the Gold Medal.

"Myelography in the Diagnosis of Herniations of Cervical Intervertebral Discs" was the title of an exhibit arranged by Drs. Arthur B. Soule, Jr., and Frederick W. VanBuskirk (by invitation), University of Vermont College of Medicine, Burlington, Vermont. The exhibit consisted of transparencies including a brief description of protrusions of cervical intervertebral discs, incidence, symptoms and signs, roentgen findings, technique of cervical myelography, indications for operation and technique of operation. It was illustrated with drawings, photographs and roentgenograms of proved cases.

Of considerable diagnostic value and interest was an exhibit entitled "Abdominal Aortography: Technique and Clinical Application" by Drs. Paul C. Swenson, Frederick B. Wagner, Jr. (by invitation), and Calvin L. Stewart (by invitation), Jefferson Hospital, Philadelphia, Pa. This exhibit showed translumbar puncture of the abdominal aorta for injection of contrast media; techniques of injection and roentgenological examination. Cases were exhibited showing reproductions of films, indication for examination, and conclusions. A paper on the same subject was given in the scientific program.

An exhibit of timely interest was one entitled "Poisoning in Beryllium Production: Chemical Pneumonitis and Dermatitis" by Drs. H. S. VanOrdstrand (by invitation), Robert Hughes (by invitation), Cleveland Clinic, Cleveland, Ohio; Drs. J. M. DeNardi (by invitation), Lorain, Ohio, and Morris G. Carmody (by invitation), Painesville, Ohio. Almost all beryllium used is derived from the ore beryl, which is imported chiefly from Brazil and Argentina, although some deposits are being worked in South Dakota, Maine, and New Hampshire, and British India. The exhibit demonstrated clinical and pathological findings in workers processing beryllium from the raw ore. The demonstration showed respiratory, dermatological, and

ocular manifestations. Chemical pneumonitis was emphasized including material from four autopsied cases. The exhibit contained many illustrations in color. It was a very comprehensive one and beautifully arranged. The exhibit also contained samples showing beryllium, its production, fabrication and application. At the present time the element beryllium is playing such a strategic part in the development of nuclear fission that the ore supply is under direct control of the government. This exhibit was given Honorable Mention.

"Differential Diagnosis of Abdominal Tumors" was the title of an exhibit by Drs. Samuel Brown (by invitation), J. E. McCarthy, and Archie Fine (by invitation), Jewish Hospital, Cincinnati, Ohio. Roentgenograms were presented of the stomach and duodenum in the anterior and lateral positions showing their relationship to their neighboring structures in three dimensions. Tumors of liver, spleen, pancreas, gallbladder, extrabiliary ducts and kidneys were shown, the diagnosis of which was determined by the characteristic changes each one of them produces upon the position, shape and contour of the stomach and the duodenum.

An exhibit entitled "Bronchography in Childhood Tuberculosis" was presented by Dr. Eduardo Rivero (by invitation), Santorio Infantil Aballi, Havana, Cuba. This consisted of a series of bronchograms taken in children with primary tuberculosis, showing the alterations of the bronchi caused by infiltration, compression from enlarged lymph glands, atelectasis and endobronchial lesions. This was one of the most comprehensive and informative exhibits shown and was awarded the Bronze Medal. A paper on the same subject was given in the scientific program.

"Radiation Injury and Tolerance Dose of Normal Stomach" was the title of an exhibit by Drs. Aubrey O. Hampton, Milton Friedman (by invitation), Irving B. Brick (by invitation), and Ellery M. James (by invitation), Walter Reed General Hospital, Washington, D. C. During the course

of irradiating retroperitoneal nodes in cases of carcinoma of the testis with supervoltage roentgen rays, many patients developed atypical symptoms of peptic ulcer. Roentgenographic examination revealed unusual lesions of the stomach, many with ulcers. Some ulcers improved under medical treatment; others required partial gastric resection. In the exhibit, these lesions were described roentgenographically and with kodachrome photographs and photomicrographs. The tolerance tissue dose of the stomach was discussed. In all supervoltage roentgen therapy, it becomes necessary to know the tolerance dose of the normal deep structures rather than the skin. This exhibit was given Honorable Mention.

An exhibit entitled "Relationship of Pulmonary Calcification to Histoplasmin Sensitivity" was presented by Drs. Amos Christie (by invitation), and J. C. Peterson (by invitation), Pediatric Department, Vanderbilt University Medical School, Nashville, Tenn. This consisted of charts showing correlation of pulmonary calcification to histoplasmin sensitivity and maps showing geographical distribution of histoplasmin sensitivity. One chart showed the age distribution. There were a number of roentgenograms showing the nature of the calcification, and cultures and photomicrographs showing benign and malignant histoplasmosis. A paper on the same subject was given in the scientific program. This was one of the most important and instructive exhibits at the meeting.

"Spondylolisthesis: A Congenital Anomaly Frequently Unaccompanied by Symptoms" was the title of an exhibit by Dr. Wilbur Bailey, University of Southern California Medical School, Los Angeles, Calif. This was an exhibit of roentgenograms, posters and placards showing the main points of spondylolisthesis and its precursors. Special attention was directed to the congenital origin of this disease and the fact that it is frequently discovered in the absence of symptoms.

"Roentgenologic Demonstration of Tumors of the Thymus in Myasthenia Gravis"

was the title of an exhibit by Dr. C. Allen Good, Jr., Mayo Foundation for Medical Education and Research, Rochester, Minn. This consisted of transparencies of roentgenograms and pathologic specimens in cases of myasthenia gravis with associated thymic tumor. There was also a demonstration consisting of a moulage of the mediastinum, including the various types of tumor of the thymus. Case histories accompanied the roentgenograms. This exhibit was given Honorable Mention. A paper on the same subject was given in the scientific program.

Another valuable and interesting exhibit was entitled "Electrokymography Utilizing the Fluoroscope" by Drs. W. Edward Chamberlain and George Henny, Temple University Medical School, Philadelphia, Pa. The exhibit demonstrated a new method of recording the movements of selected points on the borders of the fluoroscopic heart shadow. A photomultiplier tube (same as used in the Morgan-Hodges phototimer) produces an electric current which varies with the amount of light which it receives. As the heart border moves in and out, it acts as a variable shutter, and the recording galvanometer of an ordinary electrocardiograph produces a graphic tracing of the heart border motion. The method has already made a place for itself in the Physiology Laboratory as well as in Clinical Cardiology. This exhibit was awarded the Silver Medal.

"Tumors and Chronic Inflammatory Diseases of the Small Intestine" was the title of an exhibit by Dr. Barton R. Young, Temple University Medical School, Philadelphia, Pa. This exhibit was made up of a number of illustrations revealing changes in morphology and motility of the small intestine on the basis of chronic inflammatory and neoplastic diseases. Emphasis was placed on the abnormalities in the small intestine, detected by roentgen examination, in patients with regional enteritis, especially the smooth unusually multiple stricture, separated by normal appearing sections of bowel (skip areas). Chronic

tuberculosis of the small intestine may result in stricture formation and therefore the roentgen findings in this condition were presented and differentiated from those obtained in non-tuberculous regional enteritis. The exhibit included illustrations of severe small intestinal changes with obstructive manifestations in protracted deficiency disease (non-tropical sprue) and eosinophilic granuloma. The roentgen findings of several tumors of the small bowel including carcinoma, malignant carcinoid and hemangioma were demonstrated. The roentgenograms of the above mentioned conditions were supplemented by photographs of the surgical specimens and the histopathology.

An exhibit entitled "Solitary Tumors of the Chest: Diagnosis in 50 Proved Cases" was presented by Dr. Robert K. Arbuckle (by invitation), Temple University, Philadelphia, Pa. Tumors of the chest having a spherical or oval contour present diagnostic difficulties by roentgenographic study. A group of 50 proved cases was analyzed to determine which diagnostic procedures are of the greatest value in arriving at an exact diagnosis. Among the tumors were examples of carcinoma of the lung, dermoids, nerve sheath tumors, etc.

"Bronchography" was the title of an exhibit by Dr. Samuel S. Peoples (by invitation), Temple University Medical School, Philadelphia, Pa. This exhibit was prepared to show the value and wide application of bronchography in the study of diseases of the chest. Essential anatomic considerations were brought out with illustrations of bronchograms of normal lungs. The technique employed in the Department of Roentgenology of the Temple University Hospital in conjunction with the Chevalier Jackson Department of Bronchology was explained, including nomenclature of the bronchopulmonary segments. Bronchograms in various lung conditions were shown to demonstrate the importance of this method for localization. The exhibit presented material on a wide variety of problems including the following: (1) cases

in which conventional roentgenograms revealed little or no abnormality while bronchograms revealed disease; (2) cases in which the bronchograms provided the indications or contraindications for surgery, in such conditions as bullous emphysema, bronchiectasis, etc.; (3) cases in which bronchograms give remarkable visualization of alteration of the volume of various lobes.

Another exhibit from the Temple University Medical School, Philadelphia, Pa., was presented by Dr. Samuel H. Fisher (by invitation) and was entitled "The Diaphragm in Health and Disease." The common variations in the outline of the diaphragm caused by tenting, costal interdigitations, local weaknesses and displacement by gaseous distended viscera were illustrated. The pathologic conditions presented were obscuration by parenchymal inflammatory disease (bronchiectasis); displacement by subdiaphragmatic abscess, a calcified cyst of the liver; two cases of primary tumors of the liver were shown with their effects on the diaphragm. The exhibit also included eventration of the diaphragm, diaphragmatic hernias including that seen with congenital short esophagus, paraesophageal hernia, hernias through the foramen of Bochdalek and the foramen of Morgagni. A case of paralysis of the diaphragm by invasion of the phrenic nerve with bronchogenic carcinoma was shown; roentgenograms were presented exposed at the height of inspiration and during the "sniff" test.

Dr. G. E. Richards, Ontario Institute of Radiotherapy, Toronto General Hospital, Toronto, Ontario presented a "Demonstration of Instrument for Aspiration Biopsies" and "Demonstration of Improved Applicators for Radium Treatment of Carcinoma of the Cervix Uteri." Included also in the exhibit was an analysis of technical factors and results of treatment of carcinoma of the cervix uteri. A paper on the same subject was presented in the scientific program.

"Boeck's Sarcoidosis in Youth of Mili-

tary Age" was the title of an exhibit presented by Drs. Bernard Roswit (by invitation) and Archie Scheimel (by invitation), Veterans Administration, Bronx, N. Y. Boeck's sarcoid is an intriguing and provocative diagnostic and therapeutic problem of rising importance and rapidly increasing frequency, affecting principally youth of military age. This exhibit was drawn from a study of 26 cases (13 proved by biopsy) in the U. S. Veterans Hospital, Bronx, New York, Department of Radiology. This potentially systemic disease has an elusive and controversial etiology. The histological unit is the "hard tubercle." The clinical picture is chameleon in character with periodic exacerbations and systemic involvement. No organ is immune, but the lungs and bones show the more interesting pathology. The course of the disease is unpredictable and chronic, with spontaneous regression or progression to death from pulmonary tuberculosis. There is yet no effective therapy for this disease. The exhibit presented all of the interesting ramifications of the problem.

Dr. Herman E. Hilleboe presented (by invitation) from the United States Public Health Service, Washington, D. C. an interesting exhibit on "Miniature Film Mass Roentgenography of the Chest." This was a pictorial and chart representation of mass roentgenography of the chest showing method of examination and comparison of 35 mm., 70 mm., and 4 by 5 inch films and graphs of estimated significant chest pathology per one thousand patients routinely examined on general hospital or clinic admission. A paper on this subject was given in the scientific program.

An exhibit entitled "Roentgenology of the Mastoid" was presented by Drs. Frank Windholz (by invitation), and Harold A. Fletcher (by invitation), Stanford University School of Medicine, Department of Radiology, San Francisco, Calif. This exhibit consisted of 168 translucencies in cardboard mountings. Most of the roentgenograms were accompanied by explanatory drawings. They illustrated

normal and pathological conditions. The development and standardization of roentgenographic technique and roentgen anatomy of standard views were illustrated on drawings, photographs and roentgenograms of bone specimens and of patients. The significance of variations of technique and of anatomy was stressed. Developments, types and disturbances of pneumatization were shown according to the theory of Wittmaack. The roentgen appearance of acute and chronic otitis media and of its complications, mastoiditis and petrositis and cholesteatomas, were dealt with in detail. Types of defects after operations, tumors, fractures, foreign bodies and malformations were exhibited. The most frequent roentgenological errors were illustrated on roentgenograms.

A very interesting exhibit was that presented by Dr. Lewis E. Etter (by invitation), Pinewood Farms, Warrendale, Pa., entitled "Post-War Views of Röntgen's Laboratory, September, 1945." This included an exhibit of books, correspondence and photographs pertaining to the life of Röntgen, as well as the views of Röntgen's laboratory taken in 1945. Several papers by Dr. Etter on this subject have been published in the JOURNAL. This exhibit was given Honorable Mention.

An exhibit entitled "Congenital Malformations Induced in Rats by Roentgen Rays: Skeletal Changes in the Offspring Following a Single Irradiation of the Mother" was presented by Drs. Josef Warkany (by invitation), and Elizabeth Schraffenberger (by invitation), Children's Hospital Research Foundation, Cincinnati, Ohio. Congenital malformations were obtained in the offspring of female rats which were exposed to roentgen rays on certain days of pregnancy. Defects of the bones of the skull, cleft palate, shortness of the mandible and malformations of the ribs and of the bones of the arms and legs were observed. Certain patterns of deformities could be established which depended upon the day of irradiation and upon the dose of roentgen rays administered. The

exhibit consisted of specimens of newborn rats cleared by the Schultze-Dawson method. They were beautifully mounted in a stand which supplied a magnifying glass for careful study of the specimens. This exhibit was given Honorable Mention. A paper on the same subject was presented in the scientific program.

"Supervoltage Radiation" was the title of an exhibit presented by Dr. Milford D. Shulz, Massachusetts General Hospital, Boston, Mass. This consisted of charts showing the results obtained in the treatment of patients with malignant tumors of the more common types with supervoltage radiation at the Collis P. Huntington and the Massachusetts General Hospitals. A paper on the same subject was given in the scientific program.

An exhibit entitled "Rapid and Convenient Method of Copying Roentgenograms" was presented by Drs. Eugene Saenger (by invitation), Children's Hospital, Cincinnati, Ohio, and David R. Limbach, Georgia Baptist Hospital, Atlanta, Georgia. The original films and miniature reproductions were shown in this exhibit and a simple method of making the reproductions.

An exhibit entitled "Opportunities for Radiologists—Veterans Administration" was presented by Dr. A. O. Hampton, Director for Radiology, Veterans Administration, Washington, D. C. This was an exhibit showing by charts, maps and photographs the many opportunities in the Veterans Administration for radiologists. Those radiologists who are interested may secure information by writing to Dr. Hampton.

"Dosage Calculations in Radium Therapy" was the title of an exhibit by Edith H. Quimby, Sc.D., Columbia University, New York. This exhibit included various charts and directions for the proper dosage calculations in radium therapy.

Another most interesting exhibit consisted of the two gavels which have been presented to the American Roentgen Ray Society. One was the gavel presented to the

Society in 1930 by Dr. George E. Pfahler of Philadelphia. This beautiful gavel was made from Alaskan ivory, the tusks more than a million years old. The second gavel was presented to the Society by Dr. Arthur W. Erskine, Cedar Rapids, Iowa, at this Forty-seventh Annual Meeting. This unique gavel was handmade by Dr. Erskine and consists of the wooden base of Röntgen's microscope—the head of the gavel; a piece of the roll top desk Dr. W. D. Coolidge used during the years he worked on the roentgen tube and ductile tungsten for lamps makes up the handle of the gavel. The block and its mahogany inlay with a sine wave making up the sounding board are from part of one of the early Snook machines. It can be seen even from this brief description that the word "unique" was used advisedly for it is beyond the realm of probability that wood from such historical materials could be made available for another gavel or that it would have the handicraft of Dr. Erskine for its fashioning. The Society is indeed fortunate in having in its possession two such beautiful and historically interesting gavels.

COMMERCIAL EXHIBIT

The Commercial Exhibit at the Forty-seventh Annual Meeting of the American Roentgen Ray Society held at the Netherland Plaza, Cincinnati, Ohio, September 17-20, 1946, was one of the best both in the matter of size and quality which has ever been arranged at any meeting of the Society. This can be seen in the fact that twenty-seven manufacturers had reserved a total of sixty-two booths and that 252 commercial exhibitors were registered at the meeting. The exhibits filled the beautiful Hall of Mirrors and extended into the third floor foyer and occupied part of the South Hall where the scientific exhibits were held.

The exhibitors gave much time and thought to the backgrounds for their exhibits. These added greatly to the effective display of the roentgenologic apparatus and the various products of interest to radiolo-

gists. The intellectual requirements of the radiologists were not neglected as three book publishers were represented with attractive displays of their books. Much of the roentgenological equipment was new and since this was the first opportunity in a long time that many or most radiologists had had to talk with the manufacturers and see the innovations, there was a constant attendance at all of the booths.

The Society is most appreciative of the continued interest shown by the manufacturers in the meeting.

The following firms were represented in the Commercial Exhibit: *Allis-Chalmers Manufacturing Company*, Milwaukee, Wisconsin; *Anso*, Binghamton, N. Y.; *Buck X-Ograph Company*, St. Louis, Mo.; *Canadian Radium and Uranium Corporation*, New York, N. Y.; *E. I. Du Pont de Nemours and Company*, Wilmington, Delaware; *Eastman Kodak Company*, Rochester, N. Y.; *Eureka X-ray Tube Corporation*, Chicago, Ill.; *General Electric X-Ray Corporation*, Chicago, Ill.; *Thomas B. Gibbs and Company*, Delavan, Wisconsin; *Paul B. Hoeber, Inc.*, New York, N. Y.; *Kelley Koett Manufacturing Company*, Covington, Kentucky; *Liebel-Flarsheim Company*, Cincinnati, Ohio; *Machlett Laboratories*, Springdale, Conn.; *F. Mattern Manufacturing Company*, Chicago, Ill.; *Wm. Meyer Company*, Chicago, Ill.; *National Synthetics*, New York, N. Y.; *North American Philips Company*, New York, N. Y.; *Picker X-Ray Corporation*, New York, N. Y.; *Schering Corporation*, Bloomfield, N. J.; *Frank Scholz*, Boston, Mass.; *Standard X-Ray Company*, Chicago, Ill.; *Charles C Thomas*, Springfield, Ill.; *Victoreen Instrument Company*, Cleveland, Ohio; *Westinghouse Electric Corporation*, Pittsburgh, Pa.; *Winthrop Chemical Company*, New York, N. Y.; *Year Book Publishers*, Chicago, Ill.; *York Microstat Corporation*, Chicago, Ill.

NEW OFFICERS

At the Forty-seventh Annual Meeting of the American Roentgen Ray Society

held at the Netherland Plaza, Cincinnati, Ohio, September 17-20, 1946, the following officers were elected for the year 1946-1947: *President-Elect*: J. Bennett Edwards, Leonia, N. J.; *1st Vice-President*: Walter W. Wasson, Denver, Colo.; *2nd Vice-President*: Paul A. Bishop, Philadelphia, Pa.; *Secretary*: H. Dabney Kerr, Iowa City, Iowa (re-elected); *Treasurer*: Wendell G. Scott, St. Louis, Mo.; *Member of the Executive Council*: W. Edward Chamberlain, Philadelphia, Pa. The *President* is Raymond C. Beeler, Indianapolis, Ind., and the *Chairman of the Executive Council* is Harry M. Weber, Rochester, Minn.

RESERVATIONS SHOULD BE MADE FOR HAVANA CONGRESS

Nearly three hundred reservations have been made for North American radiologists and their families who will attend the Second Inter-American Congress of Radiology to be held in Havana, September 17 to 22, 1946, according to an announcement by Dr. James T. Case, chairman of the General Committee for the United States. The block of rooms reserved at the Nacional, the headquarters hotel, have long since been disposed of. Additional reservations are being made at The Sevilla-Biltmore.

Requests for hotel accommodations should be directed to Mr. Mac F. Cahal, secretary of the committee, in care of the American College of Radiology, 20 North Wacker Drive, Chicago 6, Illinois.

Delegates must arrange for air or rail transportation through their local travel agent. Special trains will be operated by the Illinois Central from Chicago and the Atlantic Coast Line from New York. Reservations for the Illinois Central should be made with Mr. J. C. La Combe, 140 South Dearborn, Chicago 3, and for the Atlantic Coast Line with Mr. R. S. Voigt, 16 East 44th Street, New York 17, New York.

Reservations for special flights to be operated from Chicago and New York to Miami by Eastern Airlines may be made in Chicago at 120 South Michigan, Chicago 3,

or in New York at Park Avenue and 42nd St., New York 17.

All delegates will be forced to go via air from Miami to Havana, and return. No steamship service will be available. Reservation forms for Pan American Airways may be obtained from Mr. Cahal.

The weather in Havana in November will be warm. Spring clothes are decreed. Passports are not required.

In addition to the sixteen papers to be read by United States radiologists, there will be eighteen scientific exhibits by delegates from this country. It is expected that copies of the printed program will be available for registered delegates soon.

Representatives on the General Committee for the United States from the three cooperative societies are Dr. James T. Case, Dr. W. Edward Chamberlain, Dr. Ross Golden, Dr. Leon J. Menville, Dr. E. P. Pendergrass, Dr. B. H. Orndoff, and Mr. Mac F. Cahal.

NATIONAL INSTITUTE OF HEALTH RESEARCH FELLOWSHIPS

The United States Public Health Service announces the continuation of the National Institute of Health Research Fellowships which were created in 1945. An increased number of these fellowships will be available during 1946 and 1947.

The National Institute of Health Research Fellowships are awarded to individuals who have had postgraduate work in institutions of recognized standing in the various fields of science allied to public health, as biology, chemistry, physics, entomology, medicine, dentistry, veterinary medicine, etc.

Applications for these fellowships may be made at any time during the year, are acted upon promptly, and are effective for one year from the time of award with a possibility of renewal for a second year.

Junior research fellowships are available to individuals holding master's degrees or to those who have completed an equivalent number of hours of postgraduate study. The stipend is \$2400 per annum.

Senior research fellowships are available to individuals holding doctorate degrees. The stipend is \$3000 per annum.

These fellowships will offer an opportunity for study and research in association with highly trained specialists in the candidate's chosen field at the Institute or some other institution of higher learning.

Letters of inquiry should be addressed to The Director, National Institute of Health, Bethesda 14, Maryland.

AMERICAN COLLEGE OF RADIOLOGY

At the annual meeting of the American College of Radiology held in San Francisco on June 29, 1946, the following officers were elected for the year 1946-1947: *President*: Edward H. Skinner, Kansas City, Mo.; *Vice-President*: Edwin C. Ernst, St. Louis, Mo.; *Treasurer*: Warren W. Furey, Chicago, Ill.; Raymond C. Beeler, Indianapolis, Ind., and Edgar C. Virden, Kansas City, Mo., were elected to four year terms on the Board of Chancellors. Ralph S. Bromer, Bryn Mawr, Pa., was elected to the Board of Chancellors for the one year term as representative of the American Roentgen Ray Society; Sidney J. Hawley, Seattle, Wash., was elected to the Board for a one year term as representative of the Radiological Society of North America, and Douglas Quick, New York, was elected to the Board for a one year term as representative of the American Radium Society.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

The Rocky Mountain Radiological Society held its Midsummer Radiological Conference in Denver, Colorado, August 8, 9 and 10, 1946. Dr. Ross Golden, Dr. H. Dabney Kerr, Dr. William E. Costolow and Dr. John D. Camp were guest speakers. The following officers were elected for the ensuing year: *President*: Lewis G. Allen; *President-elect*: James P. Kerby; *1st Vice-President*: Ira H. Lockwood; *2d Vice-President*: H. M. Berg; *Historian*: John Bouslog; *Secretary*: Alfred M. Popma.

UTAH RADIOLOGICAL CONFERENCE

There has recently been established the University of Utah Radiological Conference which is to be held the first and third Thursdays of each month from 7:30 to 10 p.m. at the Salt Lake County General Hospital from September to June. The conference is held by the Department of Radiology of the University of Utah School of Medicine for the combined purpose of graduate instruction and staff discussion of diagnostic problems. All physicians are invited to attend and to bring with them interesting or problem cases for presentation. The speaker at the first conference is to be Dr. John Caffey, Associate Professor of Pediatrics, College of Physicians and Surgeons, Columbia University and Roent-

genologist to the Babies' Hospital and Vanderbilt Clinic, New York. The Secretary of the conference is Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City.

AMERICAN BOARD OF RADIOLOGY

There are many Diplomates and candidates with applications on file whom we are unable to reach from their last known address. All Diplomates of the Board and candidates for examination are requested to notify the office of the Secretary of their present address.

B. R. KIRKLIN, *Secretary*
American Board of Radiology
Mayo Clinic, Rochester, Minn.



DEPARTMENT OF TECHNIQUE

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ROENTGENOGRAMS IN RELIEF

By CAPTAIN ELI STARR

MEDICAL CORPS, ARMY OF THE UNITED STATES

ROENTGENOGRAPHY and photography are very closely related fields. Both deal with the recording of images upon chemically treated bases; both are made possible through the use of sources of radiant energy.¹ Yet photography,

scrap roentgen film. Some of these experiences were enlightening and are being set down because they may be of general interest.

The essential steps of any type of photography are as follows:

An intermediate negative commonly referred to as the negative or intermediate is made; in it the tonal relations of the image are reversed. Then a print (facsimile) is made from the intermediate by any of the common photographic printing procedures, or by photographing the intermediate by means of suitable equipment.³

Duplicate negatives (intermediates) can be made by means of an intermediate positive. A film positive is made from the original negative and is then printed on another



FIG. 1. Conventional roentgenogram of the chest shows a large cavity and fibrosis in the right upper lobe.

through its great commercial value, has made greater strides than its sister science, roentgenography. The general disinterest of the average radiologist in dark room technique has contributed to the retarded development of roentgenography.

Interesting observations in photography prompted me to apply photographic methods to roentgenography at an army station hospital roentgen-ray department. Accepted procedures have been tried out with



FIG. 2. Facsimile ("positive roentgenogram") of Figure 1.

piece of film to produce the duplicate.⁴ Duplicate negatives can also be produced by the reversal phenomenon due to solari- zation, without the use of an intermediate positive.²

I suggest yet another method of dupli- cating negatives. This method can readily be used in every roentgenological depart- ment. No expenditure for additional equip- ment is necessary. The reproduction of fac- similes or duplicates of roentgenograms or photographs becomes a matter of a few minutes.

The back intensifying screen of an or- dinary 14×17 inch cassette was removed. (Later it was found that covering the screen with black paper sufficed.) A photograph (facsimile) on velox paper was placed against the front intensifying screen with its face side toward the screen. In the dark room an unexposed film was put upon the print and the cassette was tightly closed. An exposure of 50 kv. (peak), 0.3 second, 30 ma., at 30 inch distance was made. After developing this film an intermediate of the photograph was obtained. Similar results were obtained with typewritten matter. These intermediates could be printed either

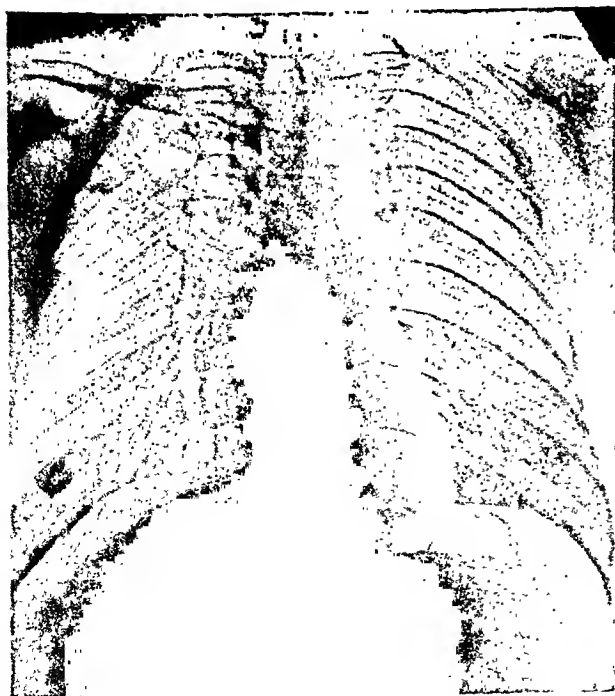


FIG. 3. Relief roentgenogram of Figure 1.

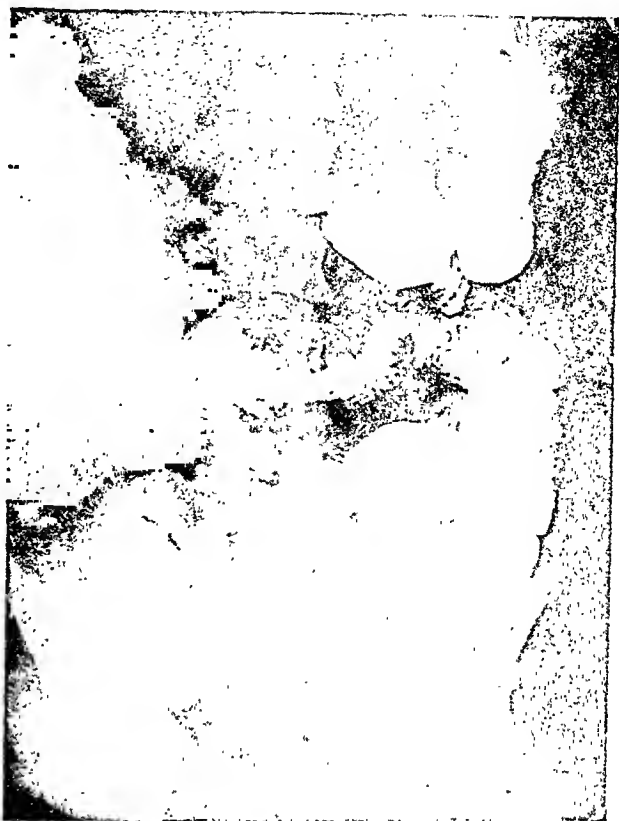


FIG. 4. Conventional roentgenogram of stomach and small intestine.

by roentgenographic exposure in this cas- sette or by common photographic reproduc- tion methods. Good facsimiles resulted in either instance. Thus, it was learned that the fluorescence of an intensifying screen and roentgen radiation are adequate to pro- duce good intermediates of photographs and also that good facsimiles can be ob- tained from these intermediates, either by roentgenographic exposure within this mod- ified cassette or by exposure to light in a printing frame.

These interesting experiences were again repeated using roentgenograms in the place of photographs and printed matter. With this modified cassette, wherein the back-intensifying screen had been re- moved, intermediate positives of roent- genograms were made as follows:

The conventional roentgenogram was put in contact with the intensifying screen. In the dark room an unexposed film was put on top of the roentgenogram and the cassette was closed. An exposure at 50 kv. (peak), 30 ma., 0.3



FIG. 5. Facsimile ("positive roentgenogram") of Figure 4.

second, and 30 inch distance was made. The resulting film was a positive of the roentgenogram, in which the tonal relations were reversed. It is suggested that intermediate positives of roentgenograms be referred to as "positive roentgenograms."

The roentgenogram must be considered solely as a series of brightness differences, since from a photographic standpoint its details are nothing more than variations in the densities of the silver deposit.³ The "positive roentgenogram" is the reversal of these brightness differences, the detail being recorded upon a transparent base in grays and black.

A comparison of the diagnostic qualities of the "positive roentgenogram" with the conventional roentgenogram can best be made if both are considered with respect to contrast (extent of the scales of tones) and secondly from the degree of opaqueness or density.³ Properly exposed "positive roentgenograms" should duplicate the di-

agnostic qualities of the roentgenogram. There should be no loss in either contrast or density. However, technical difficulties make this quite impossible. Therefore the conventional roentgenogram is usually superior in richness of detail. True as this may be, the untrained observer expresses a preference for the "positive roentgenogram."

Medical officers who have viewed both the roentgenogram and the "positive roentgenogram" feel that the "positive" is a much richer and more natural reproduction of organs in shadow. This is very true since the "positive roentgenogram" is a facsimile of the roentgenogram upon film. Another reason for this preference is the visual impression of transillumination. The image appears interposed between the light source and the observer. This transilluminating effect imparts a sensation of relative depth, which is more apparent than real. Yet,



FIG. 6. Relief roentgenogram of Figure 4.

because of it, the "positive roentgenogram" is enriched.

Further experimentation with conventional and "positive" roentgenograms led to the consideration of roentgenograms in relief. Relief being line and shadow effect, it was realized that the superimposition of the "positive roentgenogram" upon the conventional would produce shadow effect in the roentgenogram. This was done and immediately the detail became plastic.

To attain relief effect, it is important to observe the following:

The conventional roentgenogram is mounted on the illuminator. The "positive roentgenogram" is superimposed upon it in such a manner that an approximate 5 mm. lateral shift to either the right or left is obtained. However, it is best that the "positive" be shifted from right to left until maximal relief-effect is apparent.

The average illuminator was found unsatisfactory for viewing superimposed roentgenograms for relief effect. The luminosity or intensity of light was insufficient for proper visualization. To overcome this difficulty, the daylight bulb from one of the older illuminators was removed and replaced by a photoflood No. 1 bulb. This modified illuminator enhanced the relief effect.

Both transparencies and photographs were made from these superimposed relief-producing roentgenograms. The transparencies were superior to the photographs since the range of densities in an image on a film base can be more readily seen when it is

viewed by transmitted light and only a portion of the same range of densities can be seen when the image is on a paper base and is viewed by reflected light.³ True as this is, the illustrations reproduced here do demonstrate relief effect.

SUMMARY

The fluorescence of the front intensifying screen of a cassette and roentgen radiation have been shown adequate for production of good, printable, intermediates of photographs and printed matter; and for the reproduction of facsimiles from these intermediates. Facsimiles of roentgenograms upon film have been discussed. Roentgenograms in relief resulted from the superimposing of these facsimiles upon the conventional roentgenograms.

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The author wishes to express his thanks to Major Abner Stern and Corporal Felix J. Barth for their helpful suggestions and assistance.

REFERENCES

1. DE CARVAJAL-FORERO, J., and THOMPSON, M. R. Roentgenography of soft tissues by monochromatic roentgen radiation and color-forming developers. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 50, 248-257.
2. HENNY, G. C., BIRD, G. C., JR., and STAUFFER, H. M. Duplication of roentgenograms by light reversal process. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 49, 554-555.
3. Making copies of radiographs. *Radiog. & Clin. Photog.*, 1942, 18, No. 4, 86-93.
4. Kodak Data Book on Copying. Eastman Kodak Co., Rochester, N. Y., 1943, pp. 24-25.



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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS GENITOURINARY SYSTEM

DRAPER, J. W., and SICELUFF, J. G. Excretory cysto-urethrograms. *J. Urol.*, April, 1945, 53, 539-544.

The authors have developed a technique for visualization of the bladder and urethra. Five exposures are made. The patient first voids and then lies supine on a tilt table. After introduction of a urethral catheter 120-180 cc. of air is injected slowly and the catheter clamped. A film of the bladder is exposed in the oblique position. The air is then removed and 15-20 per cent skiodan is injected through the catheter until the patient has the desire to void. The catheter is withdrawn and the table tilted to the upright position. With the pelvis tilted 30 degrees from the table and the patient's right foot resting on a 10 inch block a roentgenogram is made while the patient voids into vessel. He is asked to stop voiding and a film is exposed immediately while the sphincter muscles are contracting. The patient again voids and a penis clamp applied when the stream has been established. The patient is urged to continue to attempt to urinate against the resistance of the clamp and a film exposed to demonstrate the urethra. A final film is exposed after the bladder has been emptied.

In the article roentgenograms are reproduced to show how this technique can be employed to demonstrate bladder diverticula, urethral strictures and partial urinary incontinence following paralysis of the sacral plexus.—*R. M. Harvey.*

PRITCHARD, W. Notes regarding intravenous urograms based on 2000 series in eighteen years. *J. Urol.*, Feb., 1945, 53, 387-392.

The author has reached the following conclusions as a result of his experience in performing 2,000 intravenous urograms: (1) a suitable table is required with cystoscopic and roentgen-ray facilities, which can be converted rapidly from the vertical to the Trendelenburg position, high milliamperage and a speed Bucky-Potter grid are essential; (2) the only cases in which the examination is contraindicated are patients

in shock with a blood pressure below 80 and cases with marked or complete suppression of urinary secretion; (3) patients should be prepared by abstinence from fluids for eighteen hours prior to the examination and omission of breakfast the morning of the examination; (4) a rough functional test of concentrating power of the kidney is furnished by having the patient hold his urine for two hours before the test and testing the specific gravity of this retained specimen; (5) the quantity of dye to be given should be based on grams of iodine and should be proportional to the patient's weight, age and concentrating power; children can be given twice as much dye per proportionate weight as adults, and infants three times as much. In patients with poor concentrating powers the amount of dye must be increased; (6) rapid injection of the dye is essential and for this purpose the author preheats the forearm with an electric pad and selects a large vein; (7) the patient is placed in 15 degree Trendelenburg position between exposures; (8) the first film is made three minutes after the injection, ureterograms and cystograms are taken as indicated and a compression binder with rubber bag inflation is used when gas is a problem.—*R. M. Harvey.*

SARGENT, JAMES C. Injuries of the kidney. *J. Urol.*, Feb., 1945, 53, 381-386.

Urinary tract injuries are as a rule symptomless and may be overlooked for hours unless a urine specimen is obtained and examined in all cases where a kidney injury is a possibility. Gross hematuria demands investigation. Most cases of renal injury are better handled if put to bed and let alone. This is because of the shock usually associated with such injuries and the natural reparative power of the kidneys.

The author has found excretory urography following serious accidents valueless and often misleading for the following reasons: suppression of secretory function in an injured kidney, obscuring of kidney pelvis by blood clots and obscuring of renal detail by concomitant ileus. The author feels that the retrograde pyelogram should be made a routine in all accident cases in which there is a possibility of renal damage.

Comparatively good preservation of the contour of the kidney pelvis indicates non-operative treatment while complete disruption of the pelvis indicates an immediate nephrectomy. Illustrative cases are given.—*R. M. Harvey.*

NELSON, O. A. Arteriography in renal and abdominal conditions. *J. Urol.*, April, 1945, 53, 521-533.

The pioneer in arteriography of the abdominal organs by aortic injection was dos Santos. Nelson's technique for this procedure is based on that of dos Santos. He uses a pressure apparatus with a No. 18 gauge needle, 12 cm. in length, a fast Potter-Bucky grid and a tube with a capacity of 500 ma. Eighty per cent sodium iodide is used as the medium. Needless to say, a knowledge of anatomy is a prerequisite to the aortic puncture. The patient is given 2 oz. of castor oil the afternoon before the examination and takes nothing but liquids from then until the time of the examination. Pentothal sodium is the anesthetic employed; a skin puncture is made under antiseptic precautions and the needle introduced just below the 12th rib 3 to 4 fingers' breadth to the left of the spinous process. The needle is directed downward and inward to the body of the 12th dorsal vertebra, is allowed to glide downward and over the lateral border of this body and advanced forward into the aorta. The injection is made under 1.5 atmospheres of pressure, after connecting the needle to the pressure apparatus.

An exposure is made immediately after the introduction of 6 to 8 cc. of medium. There are three hazards to this technical procedure; acute iodism, which was encountered in a mild form by the author in the early cases but has not occurred since the institution of the intravenous administration of 1,000 cc. of glucose (5 per cent) in normal salt solution immediately after returning the patient to bed; extra-aortic injection of the medium, this may cause some pain but the author does not feel it is a serious hazard; and extravasation of blood through the needle wound in the aorta. Nelson does not believe that leakage will occur from perforation of the aortic wall by a No. 18 gauge needle. He concludes that aortic puncture has no more hazard than a spinal puncture or cystoscopy. Five arteriograms made with this technique are presented with the author's interpretation.—*R. M. Harvey.*

LEADBETTER, W. F., and ENGSTER, H. C. Problem of renal lithiasis in convalescent patients. *J. Urol.*, Feb., 1945, 53, 269-281.

The formation of calculi in patients long bed-ridden has been previously described. The more vigorous the life the patient has led prior to his incapacitation and the more complete the incapacitation, the more likely the development of renal calculi. These calculi are usually not recognized until activity of the patients is resumed unless infection supervenes.

The authors report a series of 14 cases in military life in which urinary calculi were discovered and presumed to have developed in completely immobilized patients during the period of their immobilization. These patients all had severe enough colic to require a urological consultation. The average time between immobilization and the development of urinary symptoms was seventy days. Inadequate fluid intake appears to be an important factor in the predisposition toward calculus formation.

The involvement was bilateral in 5 cases. The authors found the most useful single diagnostic procedure to be intravenous urography and this is advisable as the primary procedure. Calculi were found cystoscopically in only 4 cases. All cases exhibited hematuria.

As prophylactic measures for prevention of formation of calculi in bed-ridden patients the authors suggest adequate fluid intake, frequent turning of patients in bed, and avoidance of alkalinization of the urine by dilution through forced fluids.—*R. M. Harvey.*

BENJAMIN, J. A., and BOYD, H. L. Renal tuberculoma and tuberculous perinephric abscess. *J. Urol.*, Feb., 1945, 53, 265-268.

The authors report the case of a twenty-nine year old white woman who had been in contact with a sister with active pulmonary tuberculosis. The patient was admitted to the hospital with complaints of weight loss, nausea and vomiting, frequent dysuria, dull ache in the left costophrenic angle, and fever. Tubercle bacilli were found in the smears of the urine but a roentgenogram of the chest was negative. A flat roentgenogram of the abdomen showed a fuzzy border of the left psoas muscle shadow and the medial border of the left kidney. Roentgenoscopic examination showed elevation of the left dome of the diaphragm with limited excursions.

Intravenous and retrograde pyelography

showed a crescentic pressure effect on the upper and middle calices of the left kidney suggesting cyst or tumor. An exploratory operation revealed a perinephric abscess with thick pus which showed acid fast organisms on smear. The kidney was removed at a later operation and showed a large caseous mass in the upper pole which had the pathological characteristics of a tuberculous lesion.—*R. M. Harvey.*

FLOCKS, R. H. The preventive treatment of calcium urolithiasis; important role of early and frequent roentgenographic examinations. *J. Urol.*, March, 1945, 53, 427-439.

Conditions known to predispose toward stone formation include immobilization of the individual, paralysis of portions of the urinary tract, and trauma leading to obstruction and infection of the urinary tract. Frequent and early roentgenographic check-ups of the genitourinary tract are essential in the presence of any of these predisposing conditions.

The fundamental causes of calcium urolithiasis are hypercalcinuria, urinary stasis and urinary tract infections. To counteract the first cause, dilution of the urine by a large urinary output, a high vitamin A and B intake and an acid ash diet are essential. To counteract stasis frequent change of position of the patient, adequate drainage of the urinary tract by catheter and surgery and a large fluid output are essential. Infection is counteracted by the maintenance of a large fluid output, adequate drainage and chemotherapy.

In all patients in whom prolonged immobilization is required frequent roentgen examination should be made during the period of immobilization and then every three months for one year. The author's technique is to expose a plain film of the abdomen before and after injection of 20 cc. of diodrast. By use of this procedure routinely in immobilized patients irreparable damage to the kidneys from silent stones may be prevented. The author illustrates the importance of frequent roentgen check-up examinations with case examples, including reproduction of roentgenograms.—*R. M. Harvey.*

DONALDSON, S. W. Extravesical lesions causing bladder neck obstruction. *Radiology*, Oct., 1944, 43, 319-324.

The author has failed to find in the literature any study of obstruction of the neck of the bladder from extravesical causes. He therefore de-

scribes 5 such cases, giving roentgenograms showing the findings. Three were in women and 2 in men. The causes in the women were cervical fibroid, retroverted fibroid uterus and prolapsed fibroid uterus; those in the men were a chordoma of the sacrum protruding into the pelvis and a sarcoma of the left side of the bony pelvis. The causes of obstruction in the women therefore originated in the uterus and those in the men in the bones of the pelvis. Lesions of the lower bowel involving the rectum rarely cause obstruction of the neck of the bladder, probably because of natural mobility of the gut and of the pelvic fascia which serves as a barrier.

Extravesical lesions causing obstruction of the neck of the bladder are not hard to diagnose. They should be suspected if there is a pelvic mass and a negative cystogram. Extravesical tumors do not usually cause the rectal symptoms and venous stasis caused by retroperitoneal tumors. Careful pelvic and rectal examinations should be made and cystograms made. Blood urea determinations and kidney function tests should be performed. Early diagnosis should be made and treatment given in order to prevent irreparable damage to the kidney.—*Audrey G. Morgan.*

O'CONOR, VINCENT J., and GREENHILL, J. P. Endometriosis of the bladder and ureter. *Surg., Gynec. & Obst.*, Feb., 1945, 80, 113-119.

Endometriosis of the Bladder. Vesical endometriosis was first described by Judd in 1921 under the title "Adenomyomata presenting as a tumor of the bladder."

Incidence. It would appear that vesicle endometriosis is always secondary to pelvic endometriosis that has extended into the bladder from affected contiguous organs. It is presumed to be a relatively rare complication as indicated by the fact that only 58 authentic instances have been recorded in the literature.

Origin and Pathogenesis. Theories—(1) from inactive embryonic rests derived from remnants of the wolffian and muellerian ducts; (2) due to some hormonal or inflammatory stimulation, the endothelial cells of the peritoneum undergo metaplasia and assume the characteristics of endometrium; (3) origin from the endometrium and *always* from the endometrium.

Pathology. Invasion of the bladder by endometrial tissue may result in the formation of single or multiple tumors which vary in size

from a small pea-like excrescence in a bluish-black cyst several centimeters in diameter. The endometrial glands are scattered throughout a highly cellular stroma which is contiguous with the surrounding muscle bundles. The glands are composed of low to high columnar epithelium and in some areas the cilia of the epithelium may be discernible.

Symptoms and Signs. In 7 of the 58 patients studied the endometriosis was supposedly confined to the bladder and no intra-abdominal pathology was noted. Description of the mass varied from an almond to that of a small orange in size. When present the palpable tumor is usually tender and vaginal pressure upon it may reproduce the discomfort which caused the patient to seek relief.

Subjective bladder symptoms are variable. Some types of cystic disturbance was recorded in only two-thirds of these patients. The most constant symptom seems to be a sense of pressure or weighty discomfort in the vesicovaginal region. In some cases this was partially relieved by voiding but in others the pain was constant. Dysuria, frequency, and urgency are reported but no definite pattern of symptoms is described. Gross hematuria occurs much less frequently than one would expect. It was noted in less than one-third of the patients. The cyclic discomfort, which in the main was most apparent from two to fourteen days of each month, was not characterized by a definite menstrual association.

Cystoscopic Findings. The appearance may or may not be similar to the appearance of a "chocolate cyst" of the ovary. In many instances the mucosal changes have been reported as definitely cyclic in character. The mucous membrane is elevated and the tumor is usually markedly congested and edematous. The tumor is often larger during menstruation and less cystic during the intermenstruum.

Contributing Factors. Goodall considers endometriosis a product of our civilization, in that late marriages and still later conceptions are the rule. Ovaries afflicted with endometriosis are, in his opinion, unusually prolific, filled with ova, and with the product of developing matured and defective follicles.

Treatment. In the treatment of endometriosis, the problem is how best to effect a cure with the least amount of mutilation, not only physical but functional. For the inception of all types of endometriosis, the ovaries are essential organs and their continued function

keeps up the activity of the disease. Removal of the ovaries, or the arrest of their function by natural or artificial means, usually causes an abrupt ending of the disease. Occasionally, removal of the ovaries does not arrest the disease.

In younger women, where one should make a sincere effort to preserve as much ovarian tissue as possible, localized excisions of involved areas should be practiced. Unfortunately, in these patients, recurrences are not uncommon and further surgery may be necessary to effect a permanent cure.

Roentgen irradiation of the ovaries or castration, in women approaching the menopause, should usually be followed by disappearance of the bladder involvement.

Large doses of androgen in a few reported instances seem to have been helpful in causing local tumor regression while awaiting the natural menopausal changes.

Endometriosis of the Ureter. A review of the available literature has revealed only one previously reported instance of intraureteral endometrioma. The authors report a case in a fifty year old widow in whom the diagnosis was "endometriosis of the ureter, with hydroureter and hydronephrotic atrophy of the kidney."—*Mary Frances Vastine.*

PEREIRA, ATHAYDE. Câncer da prostata. (Cancer of the prostate. *Med. cir. pharm.*, March, 1944, pp. 140-156.

The author gives a general discussion of the problems involved in cancer of the prostate and an exhaustive review of the literature. In the years from 1926 to 1943 he himself has seen 95 cases of tumor of the prostate, 11 of which were carcinoma. Of these 10 were primary, 6 limited to the gland itself, 4 associated with adenoma and 1 a diffuse carcinosis with metastases. The other case was secondary from a cancer of the bladder.

The importance of preoperative care of the patient is emphasized. Among his 11 cases cystostomy was performed in 3, open hypogastric prostatectomy in 1, Lowsley's perineal prostatectomy in 1, radium treatment was given in 1 and roentgen therapy in 2. The others were not operated on. Eight of the patients are dead, 1 from late cardiopathy, 6 from late cachexia and 1 from late sepsis. Three still survive, 2 of those operated on and 1 of those not operated on. Of the 2 operated cases, 1 had a cystostomy and 1 a perineal prostatectomy.—*Audrey G. Morgan.*

NERVOUS SYSTEM

ECHLIN, FRANCIS A., IVIE, JOSEPH McK., and FINE, ARCHIE. Pantopaque myelography as an aid in the preoperative diagnosis of protruded intervertebral discs; preliminary report. *Surg., Gynec. & Obst.*, March, 1945, 80, 257-260.

The new contrast medium pantopaque (ethyl iodophenylundecylate) has now made myelography a simpler and more justifiable procedure than it was in the past. The exact level of the lesion may be localized and operation limited to exploration at the precise interspace. This seems preferable to operative exposure at two levels, which is sometimes necessary before the protruded disc is found.

No untoward reactions are to be expected from the use of pantopaque if the agent is removed immediately following the examination. Removal can almost always be accomplished with ease by aspiration through a 20 gauge needle. If for any reason the agent is not removed it does not give rise to any greater reaction than does lipiodol, and in time is apparently larger, if not wholly, absorbed.

In the present study 36 pantopaque myelograms were done on patients with symptoms simulating those seen in the presence of a unilateral herniated nucleus pulposus. The results may be summarized as follows:

1. In 2 of these patients myelography indicated the presence of bilateral protrusion of a disc, which in 1 case was at two different levels. In 2 of the other patients, diffuse intradural pathology, probably arachnoiditis, was demonstrated.

2. It is believed that these findings illustrate the unreliability of a diagnosis based on clinical signs and symptoms alone. Clinical criteria indicated the presence of a unilateral herniated disc in each case and if relied upon would have failed to reveal the presence of a herniated disc on the opposite side or an intradural pathological lesion.

3. If errors in diagnosis are to be reduced, it is therefore advocated that, before a patient is subjected to operation, pantopaque myelography be carried out in the cases suspected of having a herniated nucleus pulposus in the lumbar region.—*Mary Frances Vastine.*

EAGLESHAM, D. C. Observations on opaque myelography of lumbar disc herniations. *Brit. J. Radiol.*, Nov., 1944, 17, 343-348.

Herniated discs in the lumbar region can be

diagnosed by the use of myelography, using lipiodol or pantopaque as an opaque substance. The herniations are generally at the level of the 4th or 5th lumbar or 1st sacral vertebrae and so the oil should be injected between the 2d and 3d or 3d and 4th lumbar vertebrae so that any deformity caused by the needle may be differentiated from the herniation. Three cubic centimeters of oil are adequate for the examination but 5 to 6 cc. are to be preferred. Four types of deformity of the myelogram are produced by the herniated disc: (1) indentation at the level of the disc space or slightly above or below it is the most common; (2) displacement of the oil column is infrequent; (3) there may be partial or complete block, partial block may cause an "hour-glass" image; (4) lack of filling of the nerve root sheaths. These types of deformity are illustrated by myelograms. Artefacts which cause difficulty in interpretation may be caused by indentation of the oil column by the lumbar needle if it is left in place during the examination, or by the extradural or subdural injection of oil.

If in addition to one or more of the above types of deformity there is thinning of the disc space, angular scoliosis at the level of the deformity, local osteohypertrophic lipping or loss of the normal lordosis, the evidence of herniation of the disc is greatly strengthened.—*Audrey G. Morgan.*

SKELETAL SYSTEM

FINKLER, RITA S., FURST, NATHAN J., and KLEIN, MICHAEL. Clinical and roentgenological study of the effects of hormonal therapy on bone growth. *Radiology*, Oct., 1944, 43, 346-357.

The effect of hormonal therapy on the growth of children has been studied at the Endocrine Clinic of the Beth Israel Hospital, Newark, N. J., for the past eight years. This article reports the results in 81 children, 18 of them treated with thyroid substance, 26 with anterior pituitary extract, 19 with chorionic gonadotropin and 18 with testosterone. Roentgenograms of the hands of children treated with these agents are given and tables showing the details of the results.

Thyroid treatment improved bone density and epiphyseal union. There was improvement in rate of growth, physical development and mental alertness. The best results were obtained in children who had had evidence of thyroid deficiency.

Treatment with anterior pituitary extract did not seem to bring about growth of bone or epiphyseal union but there was a general improvement in vitality, muscle tone and mental alertness in most of the children.

Chorionic gonadotropin treatment stimulated growth in length of the long bones but did not hasten epiphyseal union, bone maturation or density in the majority of cases. All the children showed an improvement in genital development, muscle tone, mental alertness and social adjustment. There was a loss of weight in most of the obese children.

Treatment with testosterone stimulated growth in length of the bones somewhat more than chorionic gonadotropin but did not hasten epiphyseal union. A moderate increase of bone density was noted in 3 out of 18 children. All the children showed improvement in genital development, muscle tone and self assurance and the majority gained weight. The rapid genital development made it necessary to interrupt the treatment except in 2 eunuchoid boys.

The hormone treatment brought about improvement in mental and emotional stability and improved psychological adjustment in children who were shy, self conscious or unsociable or who showed resentment against their parents or guardians or society in general.—*Audrey G. Morgan.*

ALDERSON, B. ROXBY. Stress fractures of the first rib. *Brit. J. Radiol.*, Nov., 1944, 17, 323-326.

In a series of 55,451 routine fluorographic examinations a condition was found in 35 subjects (0.63 per thousand) that was at first described as an anomaly of the first rib. It was always just proximal to the scalene tubercle; some of the cases showed an irregular transverse or oblique break in the continuity of the rib surrounded by a swelling which resembled callus. In others the swelling seemed to be fully formed bone. Three typical cases are described and illustrated with roentgenograms.

Only 5 of these individuals reported any symptoms. Two gave a history of sudden pain in the shoulder shortly after strenuous physical training, 2 reported direct trauma to the chest a few years before and the fifth said he had carried hundred weight bags of coal on the affected

shoulder and had a sore shoulder for a week or two afterward.

These were all probably cases of so-called stress fracture or fracture by muscular action. Anyone may have pain or stiffness after unusually hard labor and usually no attention is paid to it unless the pain is severe. This lesion is found quite frequently among men in Service while it is rarely found in civilians. It is probably caused by compulsory physical training and drill.—*Audrey G. Morgan.*

HABBE, J. E., and WRIGHT, H. H. X-ray evidence of old forgotten or previously undiagnosed fractures. *Radiology*, Dec., 1944, 43, 531-547.

It would seem improbable that a patient would sustain a fracture without knowing that there had been some injury sufficient to warrant medical treatment. Such cases do occur, however, and in the bones of all parts of the body. In medicolegal cases the attorney for the defense frequently argues that a patient could not have had a fracture and ignored or forgotten it, but nevertheless if roentgen examination shows evidence of an old fracture such evidence should be accepted in spite of the patient's having forgotten the injury.

Old unrecognized or undiagnosed fractures of the bones of all parts of the body including such unlikely sites as fractures of the spine and pelvis, are described and illustrated with roentgenograms. Often the old fractures are discovered on examination for a fresh injury or incidentally in examination for some other condition. Possibly fractures of the ribs are the ones that are most commonly undiagnosed, untreated and finally forgotten. Very frequently these fractures do not cause any pain or dysfunction. Another fracture that often causes increasing pain and dysfunction later even though the original injury may have been forgotten is that of the carpal scaphoid or navicular bone. In every case of industrial injury of the wrist it would certainly help the examiner if one or two special views of the wrist were taken for the purpose of ruling out scaphoid fracture. The most useful positions are a posteroanterior oblique view with the radius away from the film and a direct posteroanterior projection with the wrist in acute dorsoflexion.—*Audrey G. Morgan.*

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SOME PROBLEMS IN ABNORMAL INTESTINAL PHYSIOLOGY ASSOCIATED WITH PERITONEAL ADHESIONS AND ILEUS

PANCOAST LECTURE*

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INTRODUCTION

THE invitation of the Philadelphia Roentgen Ray Society to give the Pancoast Lecture of 1945 is an honor which I deeply appreciate. It was not my privilege to know Dr. Pancoast well. As a youngster in radiology, I looked up to him as an outstanding leader. As the years have rolled on, his writings have stood out as important contributions. I am sure he would be interested in the problems about to be presented and in some speculative suggestions about possible explanations for them.

The purpose of this lecture is (1) to examine certain aspects of ileus and some influences which affect its development and course and (2) to discuss the local effect of adhesions on the small intestine.

The discussion must begin with certain phases of normal physiology of the small intestine which seem to have a bearing on the problems in abnormal physiology associated with ileus and peritoneal adhesions.

NORMAL PHYSIOLOGY OF THE SMALL INTESTINE

Movements of the small intestine involve three anatomically distinct and physiologically different structures, (1) the *tunica muscularis*, (2) the *muscularis mucosae*, and (3) the villi. The movement of the villi is not important in this discussion.

The following facts concerning the motor physiology of the *tunica muscularis* and the *muscularis mucosae* have been assembled from various standard text books and articles and have been dealt with in more detail elsewhere (Golden, 1945).

The *muscularis mucosae* is stimulated by the sympathetic portion of the autonomic nervous system but is not affected by the parasympathetic (vagus) portion. It moves independently of the *tunica muscularis*, and produces and changes the form of the mucosal folds.

Two types of movement of the *tunica muscularis* have been described, in each of which both the longitudinal and the circular layers take part:

* Pancoast Memorial Lecture, presented before the Philadelphia Roentgen Ray Society, November 1, 1945.

1. The myogenic or pendulum movements which in the dog are not affected by cocainization of the wall and which are, therefore, independent of nervous control.

2. The peristaltic movements which are disorganized by cocainization of the wall, and which are apparently controlled by reflexes coordinated through the intramural nervous system. Relaxation precedes and follows the peristaltic movement. Bayliss and Starling (1899) observed a blanching of the wall of the dog's intestine in a peristaltic constriction, indicating a temporary ischemia. As the earliest manifestation of fatigue they noted failure of relaxation. It is obvious that relaxation is just as important as contraction in a properly-coordinated peristaltic movement. Mechanical stimulation of the tunica muscularis by pinching caused a localized contraction (King and Arnold, 1922).

The chemical mediator theory of nerve action assumes that the characteristic effects of nerve stimulation are produced through the medium of diffusible substances produced at the end plates. Stimulation of the sympathetic nerves produces adrenalin (or sympathin, as Cannon called it) and affects "adreninergic" structures. Stimulation of the parasympathetic nerves produces acetylcholine and affects "cholinergic" structures.

Acetylcholine is rapidly destroyed by a specific enzyme, choline esterase, found only in nerve tissue. Choline esterase is inhibited or destroyed by certain drugs, e.g., prostigmine. Therefore, this drug prolongs and intensifies the action of acetylcholine and acts like a parasympathetic stimulator.

Adrenalin (sympathin) occurs in two forms, the inhibitor or I form, and the excitor or E form. Undifferentiated adrenalin, the I form, inhibits only cholinergic structures and stimulates adreninergic structures. The excitor or E form is partially oxidized adrenalin which has no inhibiting power but which stimulates cholinergic structures (Darrow). Oxidation products of adrenalin inhibit choline es-

terase in vitro (Waelsch and Rackow), and, therefore, resemble prostigmine; this observation suggests a possible mechanism for the above-described excitor effect of adrenalin E.

Much remains to be learned about the normal physiology of the intestine in spite of many years of investigation. The work of the neurophysiologists will be followed with great interest by those who have to deal with the gastrointestinal tract.

ILEUS

The word "ileus" is derived from a Greek word which means colic. Dictionaries define ileus as intestinal obstruction. Actually it is used in a much broader and more complicated sense. Ileus is usually used to mean a condition in which the intestine is dilated with the accumulation of gas and fluid and with other physiologic disturbances. Intestinal obstruction and ileus are two different things. Ileus may follow obstruction—mechanical ileus—or it may occur without obstruction—paralytic or, as Wangenstein calls it, functional ileus. Obstruction or, in other words, mechanical interference with the passage of intestinal contents, may be present without ileus.

Mechanical distention of the small intestine results in a number of profound disturbances both local and general, some of which are increased secretion, diminished absorption, failure to transport intestinal contents caudad (Ochsner), reflex inhibition of movement and tonus caudad and cephalad (Youmans, Meek and Herrin), narrowing and finally obliteration of intramural blood vessels which may result in gangrene and perforation (Storck and Ochsner), rise of blood potassium and specific gravity (Childs and Scudder).

The distention of the intestine with gas and fluid makes the detection of ileus easy by roentgen methods. The routine procedure is to take films with the patient lying on either side or even erect with the rays directed horizontally to show the fluid levels, in addition to a posteroanterior or an

anteroposterior projection. Evidence of ileus can be demonstrated earlier by this means than by any other method.

Distention by gas does not obliterate the mucosal folds of the jejunum which can be seen as fine cross striations in the gas shadow. The mucosal folds of the ileum are obliterated under the same conditions, resulting in smooth margins of its gas-distended loops. These facts make it

cases the intestine was able to compensate for the obstruction because of the gradual development of the constriction, and the "other physiologic disturbances" did not occur. However, a point will be reached where physiologic compensation for the mechanical obstruction cannot continue and decompensation results. At this point the patient begins to have ileus. This apparently occurred in a seventy-year old

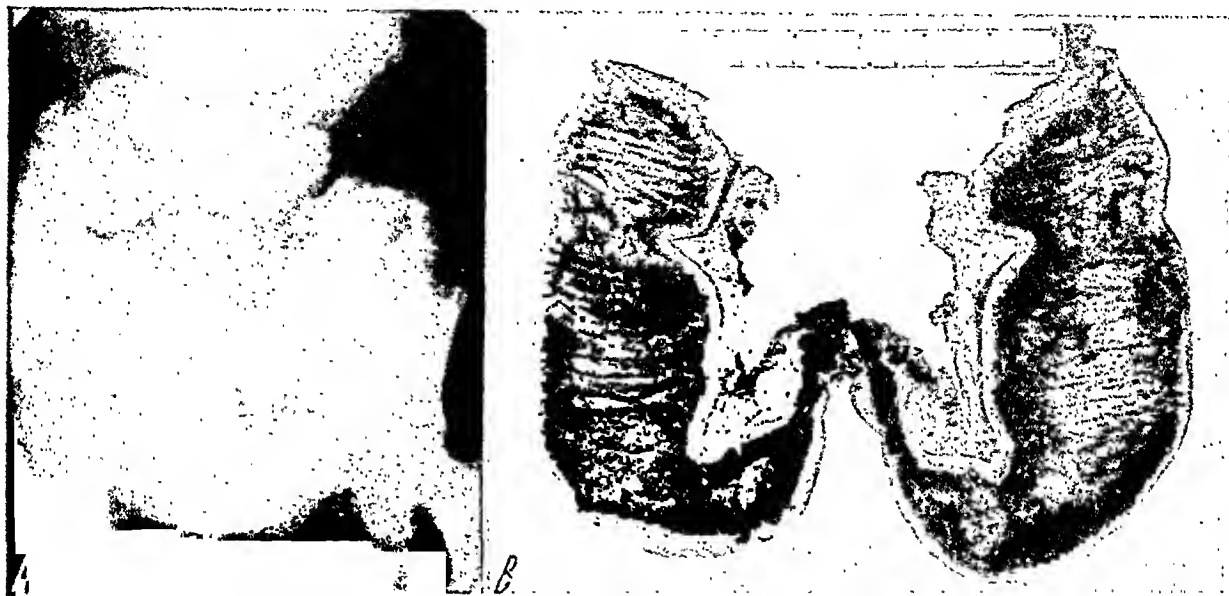


FIG. 1A. Dilatation of the jejunum proximal to a constriction resulting from regional enteritis of the lower jejunum. A twenty-six year old woman complained of recurrent attacks of diarrhea and cramping abdominal pain. The first attack occurred over three years before admission. She had none of the clinical signs of ileus. The intestine apparently compensated for the obstruction and dilatation.

FIG. 1B. Regional enteritis of the lower jejunum. The resected specimen shows apparently normal mucosal folds, hypertrophy of the wall and dilatation proximal to the slowly-developing constriction.

usually easy to differentiate between gas-distended jejunum and ileum.

A discussion of the differential diagnosis between mechanical and paralytic ileus cannot be undertaken here.

Dilatation of the intestine and accumulation of fluid may occur without ileus. Moderate dilatation and accumulation of fluid occur in sprue, and without barium studies may be confusing (Kantor). In Figures 1A, 1B and 2 are illustrated two cases with dilated intestines proximal to a mechanical obstruction, yet the patients did not have ileus. These cases serve to emphasize the "other physiologic disturbances" in our concept of ileus. In these two

business man who came to New York to attend a convention. After two or three days he suddenly developed severe abdominal pain and distention. At the hospital gas-distended loops of intestine with fluid levels were demonstrated. Barium injected through the Miller-Abbott tube after deflation disclosed a constriction in the terminal ileum, almost the duplicate of that shown in Figure 2. At operation carcinoma at the ileocecal junction was found with metastases in the liver. Obviously, the carcinomatous constriction had been developing for months. Why did the compensation of the intestine suddenly break? Possibly loss of sleep and fatigue associated



FIG. 2. Carcinoma of the terminal ileum with a narrow short constriction (arrow). Proximal to the constriction the intestine is dilated. A fifty-five year old woman complained of nausea and malaise for two months. She had no signs of ileus. (Courtesy of Dr. Harry M. Imboden.)

with attendance at a convention had something to do with it. Wangensteen postulates a plug of something, possibly undigested food, which may close a narrow passage and so precipitate ileus: this possibility cannot be denied. However, after deflation with the Miller-Abbott tube and the injection of barium we have never found complete obstruction.

The intestine, therefore, is vulnerable to rapid distention but seems to adapt itself very well to slowly-developing distention following gradually increasing obstruction.

Paralytic ileus may be initiated by a number of causes, three of which will be discussed.

Generalized purulent peritonitis is associated with gas distention of the intestine and fluid levels. Is this dilatation the result of an effect on the intramural nervous system or of an effect on the extramural

sympathetic ganglia? In contrast, a constriction was produced by a localized abscess (Fig. 10).

Dilatation of the intestine may result from influences outside of and even remote from the intestine itself, e.g., pneumonia, injury of the spine, etc. A healthy seventeen-year old boy felt something give way in his back as he served at tennis but was able to finish the game. The following day the pain in the back increased steadily in severity, associated with increasing abdominal distention. By evening the pain was so severe that he was given morphine, without relief. During the following twelve hours he received a total of 90 mg. of morphine without effect on the pain. At the hospital the following morning he was given intravenous anesthesia so that he could be moved to the x-ray table. The films showed enormous distention of the stomach and intestines with gas but no abnormality of the spine could be seen. When the patient recovered consciousness from the anesthesia, the pain was much better. During the following thirty-six hours both the pain and the distention diminished and disappeared.

Hypoproteinemia may cause ileus. A man came to the hospital with severe burns over the face, neck, chest and arms. He received infusions of normal saline intravenously. The next day he began to have abdominal pain and on the third hospital day he had ileus. Deflation with the Miller-Abbott tube gave some relief. Hypoproteinemia was found. The saline infusions were stopped and transfusions of blood were given. As the blood protein returned to normal, the ileus disappeared.

Secondary paralytic ileus may complicate mechanical ileus. In some of our cases treated by deflation with the Miller-Abbott tube, redistention of the upper part of the intestine along the tube was detected after deflation had been apparently complete. When this is detected the tube should be pulled back until the tip lies in the upper part of the jejunum and the intestine deflated again. If this maneuver is not ac-

completed quickly enough the patient may die.

This secondary paralytic ileus is often associated with hypoproteinemia. Protein depletion often exists with gastrointestinal disorders, as Jones and Eaton pointed out in 1933. It may be aggravated by the inability of the patients with ileus to take food, by loss of protein through intestinal fluids withdrawn by the Miller-Abbott tube, or even induced by incorrect treatment. This is illustrated by the following case.

A fifty-one-year old man had diverticulitis in July, 1943. On September 14, 1943, he was admitted because of increasing abdominal pain. A film on September 15 disclosed the usual evidence of mechanical ileus. The Miller-Abbott tube entered the duodenum on September 17 and progressed slowly. Although the drainage was good he did not seem to do well. Beginning the second day after admission he was given 3,000 cc. of normal saline intravenously each day. On September 17 his temperature rose and remained elevated (101° – 102° F.) until after the intravenous infusions had been discontinued. On September 20 the tube was arrested. Barium injected through the tube disclosed a kink (Fig. 3A) in the lower jejunum, which obviously represented the obstruction. The films also showed evidence of redistention of the jejunum along the tube. A film of the chest (Fig. 3B) at the same time disclosed heavy streaky shadows about both hila which were interpreted as pulmonary edema. The advisability of a blood protein determination was suggested. As no peripheral edema was present, his doctor preferred to believe that the lung shadows were due to pneumonia and gave him sulphadiazine. The blood protein was 5.1 which his doctor said was not low enough to be important. The Miller-Abbott tube was pulled back to the upper loop of jejunum. It again descended slowly, was arrested three days later, on September 23, and the kink was again demonstrated. Redistention of the jejunum along the tube was again present.

Considerably more tube length could be seen at this time than was visible three days previously although the tip was arrested at the same kink in the lower jejunum. This suggests that the intestine was longer, probably because of hypotonicity of the longitudinal muscle. A film of the chest on the 23rd showed evidence of a considerable increase in the shadows around the hila and of fluid in the right hemithorax which had not been there three days previously. The blood protein on the 23rd was 4.9. The patient's doctor finally became convinced that he was dealing with hypoproteinemia associated with edema of the lungs and secondary paralytic ileus probably due to edema of the intestine. The infusions were stopped on the 24th and a liter of plasma was given. A film of the chest on September 27 disclosed no evidence of abnormality of the lungs. The patient received a high protein, high vitamin diet and made a rapid recovery. The Miller-Abbott tube was removed. Four weeks later, after he had gained weight and was in excellent condition, the tube was inserted for prophylactic purposes and he was operated upon. The kink was due to adhesions between the lower jejunum and the sigmoid resulting from the diverticulitis.

This case illustrates several important points. The excessive use of saline infusions is dangerous. In the presence of considerable salt, edema develops at higher levels of blood protein than without it. The first evidence of edema may appear in the lungs, as Jones and Eaton pointed out in 1933. The fever, which in another case reached 105° F., appears to be related to the pulmonary edema; the shadows in the lungs disappeared much too rapidly to be due to pneumonia. Redistention of the intestine may be taken as suggestive of hypoproteinemia although other nutritional factors, which cannot be discussed here, may play a part.

Discussion of Causes and Mechanism. These cases are examples of widely divergent causes of the distention of the intestine which we call ileus. The mechanical ob-

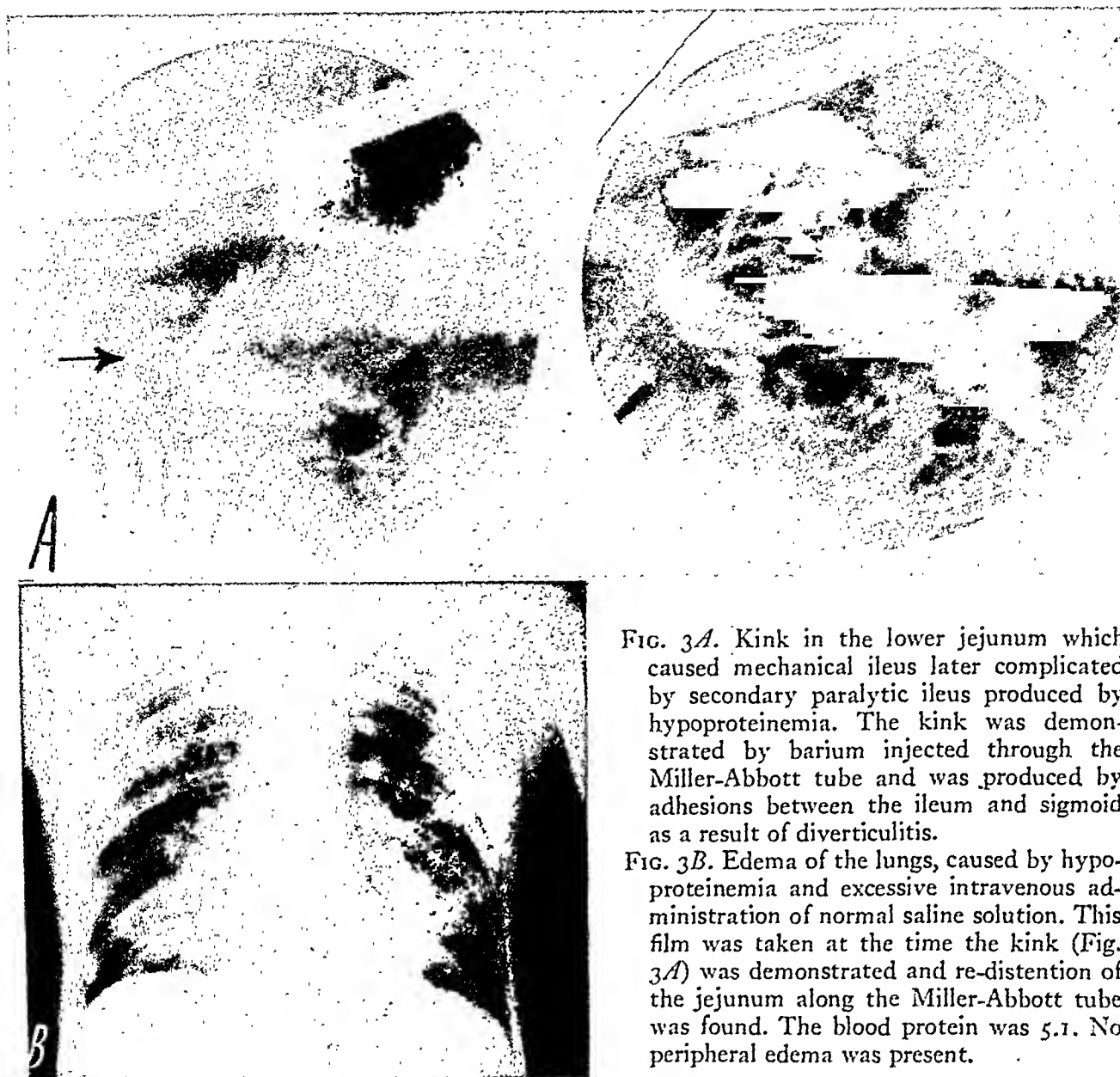


FIG. 3A. Kink in the lower jejunum which caused mechanical ileus later complicated by secondary paralytic ileus produced by hypoproteinemia. The kink was demonstrated by barium injected through the Miller-Abbott tube and was produced by adhesions between the ileum and sigmoid as a result of diverticulitis.

FIG. 3B. Edema of the lungs, caused by hypoproteinemia and excessive intravenous administration of normal saline solution. This film was taken at the time the kink (Fig. 3A) was demonstrated and re-distention of the jejunum along the Miller-Abbott tube was found. The blood protein was 5.1. No peripheral edema was present.

struction, the diffuse acute peritonitis, the wrenched back, and hypoproteinemia with edema of the intestine all appear to have exerted the same, or at least a similar, interference with intestinal physiology. How can the mechanisms set into motion by these different causes be correlated? Inasmuch as the parasympathetic nervous system is responsible for the tonus of the muscle coat, it seems reasonable to conclude that in some way the operation of the parasympathetic is interfered with. This might result from failure of the intramural nervous apparatus to produce acetylcholine in adequate quantities, as shown by Ingelfinger and Moss in sprue, or from too rapid

destruction of acetylcholine by choline esterase, or, as suggested by Wangenstein, from over-activity of the sympathetic nervous system, the normal function of which is to inhibit the action of the parasympathetics. In the case of the boy with the wrenched back, the sympathetic mechanism would seem to be the most logical. Inasmuch as a localized infection (Fig. 10) caused a localized narrowing, the generalized dilatation of the intestine produced by a diffuse purulent peritoneal infection probably originates through some mechanism outside the intestinal wall. Von Gierke believes that splanchnic (sympathetic) stimulation occurs in rapidly spreading perito-

nitis; in peritonitis of longer duration the wall is damaged through over-distention, with toxic damage of the muscle and of the intestinal nervous apparatus.

In the hypoproteinemia cases, the interference seems to be associated with edema of the intestinal wall. Important information has come from the Departments of Radiology and Surgery at the Hospital of the University of Pennsylvania (Barden, Ravdin and Frazier, 1937) on disturbances in the function of gastrointestinal anastomoses due to edema. Leigh produced hypoproteinemia in dogs and by means of a balloon found that both tonus and peristalsis were depressed as edema developed. In clinical ileus Leigh noted slower progress of the Miller-Abbott tube when the patient had edema.

Edema of the intestine is localized largely in the submucosa. In the case shown in Figure 4 the blood protein was 5.0, of which 3.1 was albumen. The mechanism whereby this submucosal edema interferes with movement and other functions of the small intestine is not clear. Hodes (personal communication) found no appreciable disorder of the small intestine in several patients with beri-beri who had peripheral edema and who might be expected to have edema of the intestine. Dogs with hypoproteinemia (Barden, Ravdin and Frazier, 1937) induced by diet have disordered intestinal movements but do not get ileus. In both of these examples the development of edema must have been slow whereas the edema resulting from excessive fluid, salt and hypoproteinemia in ileus develops quickly. We have seen how the intestine can compensate for a gradually-increasing obstruction. It seems permissible to wonder whether with slowly developing edema the intestine succeeds in compensating in some way for the excessive fluid in its walls.

When the small intestine misbehaves in patients who have gastrointestinal disorders of any kind, hypoproteinemia must be suspected, bearing in mind that other nutritional disorders may play a part. One of our recent patients had a cholecysto-



FIG. 4. Edema of the intestine due to hypoproteinemia. The total blood protein was 5.0, albumen 3.1 The fluid is collected in the submucosa, not within the mucous membrane and has produced widening of some of the folds. The separation of the bundles of circular muscle is due to artefact, not to edema. (Courtesy of Dr. Edith Sproul.)

jejunostomy with end-to-side jejunojejunostomy for inoperable carcinoma of the head of the pancreas. A few days later the patient began to vomit. An examination of the upper part of the jejunum was requested because obstruction at the anastomosis was suspected. The jejunum was atonic, slightly dilated and very sluggish. The surgical resident, present at the examination, was asked about the level of the blood protein. He said that a determination would be done immediately. Later he reported that the test showed the blood protein to be "way down" and that measures to correct the hypoproteinemia were immediately instituted. However, that night the patient disrupted his wound, an event usually associated with hypoproteinemia.

The problem of fluid, salt and blood protein regulation is complex and I am not qualified to discuss it.



FIG. 5. Segmentation with immobility of the small intestinal loops (four hours after the ingestion of barium), associated with multiple peritoneal adhesions following generalized peritonitis from acute appendicitis in a ten-year old girl. This appearance was called the "irritation pattern" by Soper. The segmentation is caused by failure of short segments of intestine to relax. Barium did not reach the cecum in four hours.

PERITONEAL ADHESIONS

Soper (1929) showed that multiple peritoneal adhesions were associated with a disturbance in the motor function of the small intestine which produced what he called the "irritation pattern." It is characterized by multiple constrictions in the barium shadows (Fig. 5).

The commonest source of adhesions which cause trouble is said to be operation for appendicitis and the next commonest is operation on the female pelvic organs. In my experience the latter is the more common.

Whatever may be the source, a knuckle or kink in the intestine can almost always be demonstrated after deflation with the Miller-Abbott tube. A typical kink is shown in Figure 6. Proximal to the kink the lumen is slightly wider than normal. Distal to the kink the lumen is approximately normal in caliber. Both limbs of the kink are narrow but the narrowing is more extensive in the distal than in the proximal limb. The kink was produced by a band of adhesions described by the surgeon as one inch in width but the narrowing shown on the film is almost twice that long. The significance of these facts will be discussed later.

Adhesions may cause pain without

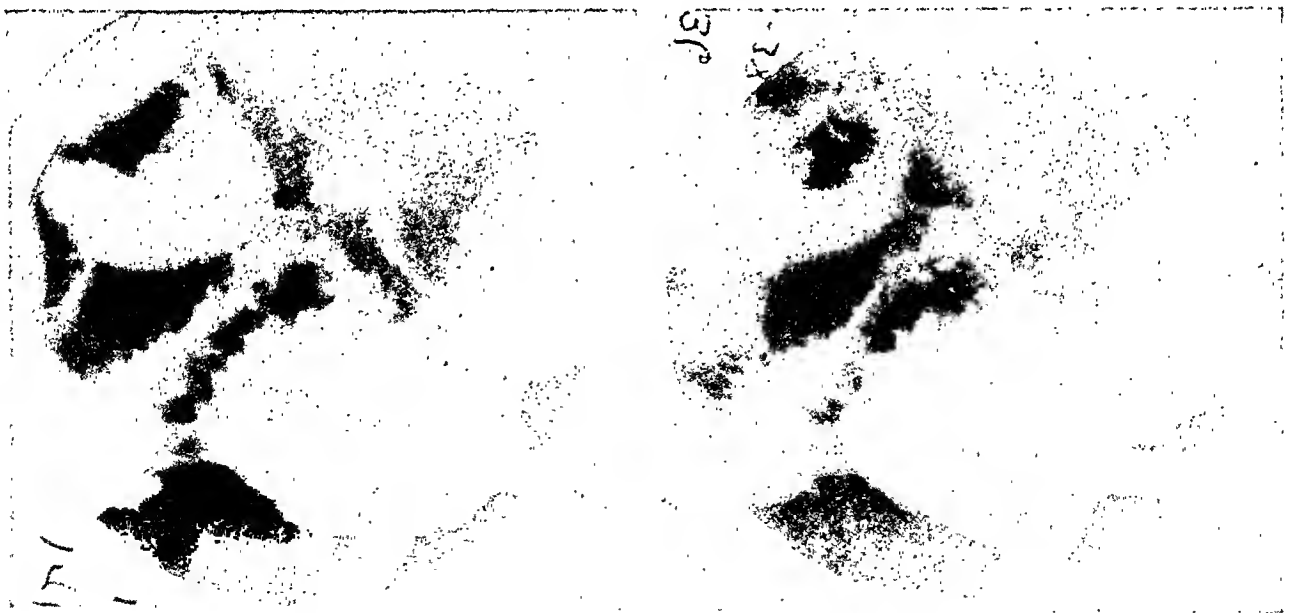


FIG. 6. A typical knuckle or kink in the small intestine uncovered by the pressure cone after deflation and the injection of barium through the Miller-Abbott tube. The adhesion in a fifty-eight year old woman followed hysterectomy; it was only one inch in length and bound the two loops together. Both limbs of the kink are narrow but the narrowing is more extensive in the distal limb.

producing ileus. In some cases the Miller-Abbott tube can be used to demonstrate and to localize with certainty the offending kink. The balloon distended with 20 cc. of air may be arrested by a knuckle which might be difficult or impossible to detect by the usual barium study of the small intestine, particularly if the knuckle lies low in the pelvis. In the case illustrated in Figure 7, the narrowing is in the distal limb. Although other adhesions were present, release of the adhesion which produced the kink was followed by relief of pain.

Not all adhesions which cause pain produce kinks or knuckles sufficiently sharp to arrest the balloon of the Miller-Abbott tube, although in our experience many of them do.

Scarring of the intestinal wall due to endometrioma produced two knuckles with narrowing. The narrowing shown by the barium shadow (Fig. 8A) is considerably longer than the sharp narrow indentations shown on the resected specimen (Fig. 8B). The narrowing in the barium shadow, therefore, could hardly be due to fibrotic constriction but must result from spasm of the muscle in the region of the lesion.



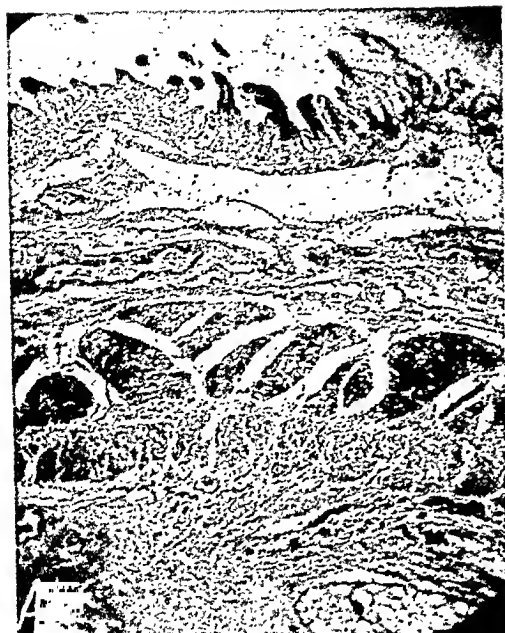
FIG. 7. A knuckle of ileum caused by adhesions following hysterectomy in a thirty-year old woman. The narrowing (arrow) is in the distal limb of the kink. The patient had repeated attacks of abdominal pain without ileus. The balloon of the Miller-Abbott tube was arrested at the site of this knuckle, which was then demonstrated by injecting barium through the tube. Release of the adhesion binding the two limbs of this loop together was followed by relief of pain.

In another case the terminal ileum was



FIG. 8A. Two narrow knuckles in the ileum (arrows) produced by scarring due to endometrioma of the wall. The narrowing of the lumen of these two segments demonstrated by the barium is considerably longer than the very sharp indentations seen on the external surface of the resected specimen (Fig. 8B). At the fluoroscopic examination barium was propelled through the knuckles without expanding the lumen.

FIG. 8B. Endometrioma of the wall of the ileum. A photograph of the resected specimen shows that the actual indentations produced by the scarring of the wall were very sharp and narrow. The narrowed lumen of the two segments disclosed by the barium shadows (Fig. 8A) must have been the result of spasm at the site of the fibrosis in the wall produced by the intramural tumor. (Courtesy of Dr. A. Purdy Stout.)



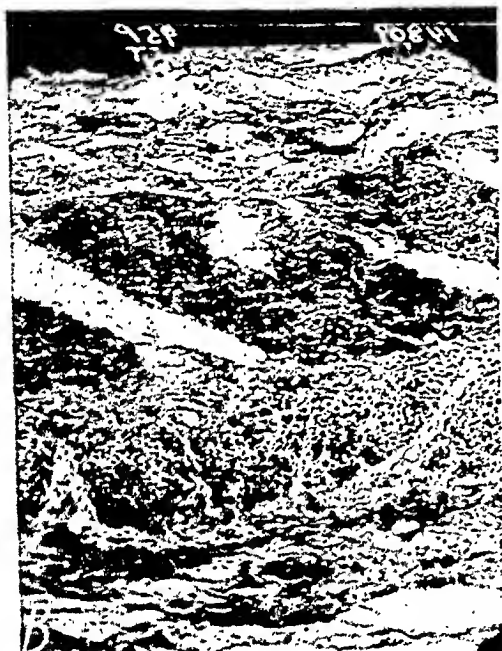
- *mucous membrane*

} *submucosa*

} *circular muscle*

} *Degenerated longitudinal muscle*

- *Fibrotic Adhesion*



} *Circular muscle*

} *Degenerated Longitudinal muscle*

} *Fibrotic Adhesion*

FIG. 9A. A low-power photomicrograph of the intestinal wall at the site of an old adhesion which caused a knuckle. The intestine was slightly narrowed at the knuckle. The fibrotic adhesion is at the bottom of the photomicrograph. The fibrosis extends through the longitudinal muscle and involves the plane between the two layers where the mesenteric ganglia of Auerbach lie. The circular layer is involved very slightly. Evidence of degeneration of the muscle cells of the longitudinal layer can be seen (see Fig. 9B).

FIG. 9B. A higher power photomicrograph shows better the degeneration of the fibrotic longitudinal muscle and the relatively normal circular muscle. (Courtesy of Dr. Edith Sproul.)

adherent to the right cornua of the uterus following operation for ectopic pregnancy with removal of the right tube and ovary. For twenty-five years after this operation the patient was plagued by attacks of right lower quadrant pain. A narrowed area was demonstrated by barium studies in the terminal ileum. At operation the ileum at the site of attachment to the uterus was

narrower than on either side of the attachment, although the adhesion involved only the margin of the intestine adjacent to the uterus and did not pass around the wall.

Discussion. Textbooks of surgery and surgical pathology attribute the intestinal obstruction produced by adhesions to mechanical pressure, traction, kinking or torsion. The observations on the cases just

described indicate that the effect of adhesions on the wall of the intestine is a little more complex than mere mechanical pressure. The narrowing at the site of the adhesions must be due to a contraction of the circular muscle and not to pressure from the outside. In meditating on this abnormal phenomenon a number of questions come to mind.

1. How deeply into the intestinal wall does the inflammatory process extend?

The answer could not be found in textbooks. When asked about it, a number of pathologists stated that they had never investigated this question carefully but had the impression the wall was involved only superficially. Dr. Edith Sproul, Assistant Professor of Pathology, kindly made some sections of the intestinal wall at the site of a peritoneal adhesion found at autopsy. The adhesion produced a knuckle by binding two loops together. The distal limb of the kink was narrower at autopsy than the proximal limb. The section was taken directly under the adhesion. The photomicrographs (Fig. 9) show that the inflammatory process extended through the outer or longitudinal layer of muscle. The region of Auerbach's plexus between the two layers is fibrosed but the inner or circular layer is involved very little, if at all. The muscle cells of the outer longitudinal layer show evidence of degeneration. Unfortunately, the section did not extend clear around the entire circumference of the wall. Similar studies of many cases must be done before conclusions can be drawn as to the pathological changes in the wall of the intestine at the site of peritoneal adhesions.

2. Does the acute inflammation or the fibrosis resulting from it produce a localized disturbance in the motor physiology of the intestine?

Figure 10 shows a narrowing of the ileum at the site of a localized abscess resulting from appendicitis. The contrast between the effect of this localized inflammation and the effect of a generalized peritonitis was commented upon above. Evidence was



FIG. 10. Narrowing of the ileum at the site of a localized abscess following appendicitis. The patient had mechanical ileus. After deflation by and arrest of the Miller-Abbott tube, the narrowed kink was disclosed by barium injected through the tube. This localized narrowing at the site of an abscess is in striking contrast to the distention of the intestine (paralytic ileus) caused by a diffuse generalized peritonitis.

presented previously that the narrowing of the lumen at the site of an adhesion cannot be attributed to purely mechanical pressure. Since release of the kink by severing the adhesion is usually followed by relief, it would seem that the fibrosis within the wall is probably not in itself responsible for pain, because the severing of the adhesion outside would not affect the fibrosis within the wall. However, in some cases the intramural fibrosis may be of importance in this respect. Consequently, it seems that both a localized acute inflammation and a fibrotic process in the wall at the site of an adhesion are capable of producing a localized disturbance in the motor physiology of the intestine, manifested by narrowing.

3. Is mechanical stimulation produced by peristaltic movements and transmitted caudad through the adhesions to the wall lower down necessary to produce the narrowing?

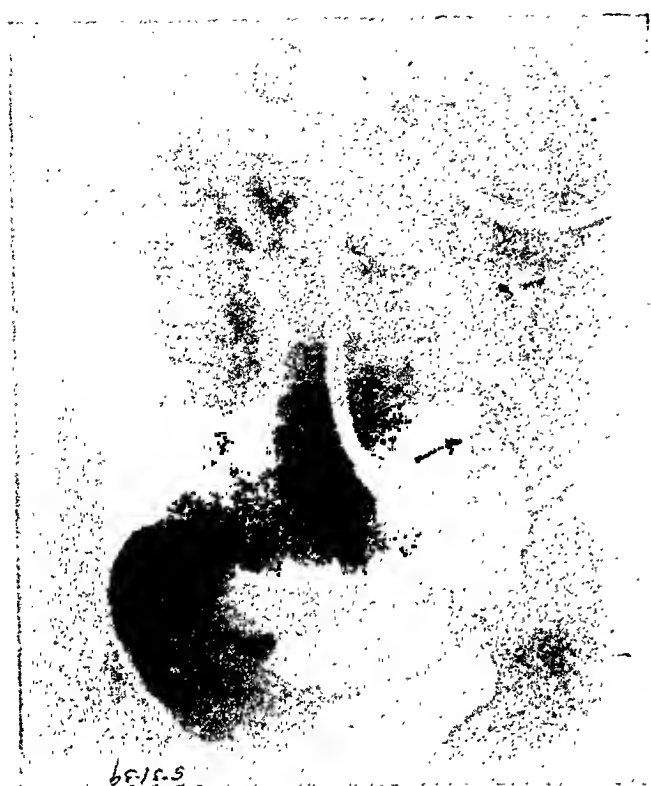


FIG. 11. Elongated narrowing of a segment of ileum associated with strangulation. This loop was caught under a shelf of adhesions. The patient, a fifty-nine year old woman, was admitted with mechanical ileus. After deflation with the Miller-Abbott tube, the narrowed loop was demonstrated by the injection of barium through the tube.

4. Why does the narrowing occur largely in the distal limb of the kink?

These two questions must be considered together. Inasmuch as mechanical stimulation by pinching causes a contraction, it would seem possible that a pull by an adhesion inserted into the wall could do the same thing. The peristaltic wave is associated with a contraction of the longitudinal as well as of the circular muscle. The pull of the longitudinal muscle would be transmitted ahead of the wave by the adhesion. This would be an explanation for the more intensive narrowing of the distal than of the proximal limb. Furthermore, under normal conditions a reflex relaxation (inhibition) of both the longitudinal and the circular muscle precedes the peristaltic contraction. It seems quite possible that a mechanical stimulus, transmitted to the wall ahead of the contraction wave, could interfere locally with relaxation and with

the orderly operation of the peristaltic reflex and thus disturb the propulsion of intestinal contents.

5. Does the mechanical stimulus affect the muscle directly, producing a contraction of myogenic origin, or does the stimulus operate through the colinergic intramural nervous system?

This question probably cannot be answered. Nachmansohn (personal communication) says that any stimulus, either mechanical or electrical, would result in the production of acetylcholine. This would amount to an effect developed through the intramural nervous system. However, both mechanisms may play a part.

6. Why does the narrowed area fail to expand when the stimulus is not active?

7. Does the failure to relax result from absence of a sympathetic effect on the tunica muscularis, from local failure of choline esterase to destroy acetylcholine, or from diminished local oxygen supply in the muscle?

Little evidence is at hand upon which an answer to these questions could be based. Bayliss and Starling observed blanching of the wall under a peristaltic wave in the dog's intestine. At operation the wall of the human stomach becomes pale under a peristaltic wave. If the mechanical stimulus is repeated frequently enough so as to prevent relaxation, is it possible that local interference with and reduction of the blood supply to the muscle may result? The long narrowed segment of ileum in Figure 11 which produced mechanical ileus was strangulated. Dr. Edith Sproul (personal communication) has observed a number of cases at autopsy in which adhesions involving the intestinal wall were associated with localized narrowing which persisted after death. Is it possible that prolonged or repeated ischemia may result in fibrosis of the muscle?

Twenty-five or thirty years ago deep incisuras in the stomach opposite a lesser curvature ulcer were not infrequently seen, but are rarely encountered now. This resulted in the B type of hourglass stomach.

The incisura presumably began as spasm but later the contracted segment of muscle became fibrotic and the constriction in the stomach became permanent. Why did the muscle change to fibrous tissue? Blanching of the stomach wall under a peristaltic wave has already been mentioned. Prolonged spasm of a narrow segment might well result in persistent ischemia. The normal result of reduced blood supply, and therefore of oxygen supply, is for cells which have a higher oxygen requirement like muscle to be replaced by cells with a lower oxygen requirement. It is an accepted principle in pathology that ischemia leads to fibrosis. This might explain the development of a permanent incisura in the stomach.

How far this analogy will fit the effect of adhesions on the wall of the intestine is questionable. Unfortunately no information is available concerning the condition of the muscle in the contracted areas of the intestine at the site of adhesions. In the single case described above (Fig. 9), the circular muscle was not fibrosed and therefore showed no effect attributable to persistent ischemia. Study of a large series of similar cases is highly desirable. It is important to determine how far the intramural fibrotic process extends around the wall beyond the externally visible attachment of the adhesion. Although the exact mechanism cannot be determined now, the failure of the narrowed area to expand in life and the persistence of narrowing after death must be the result of some abnormality within the wall not limited to the exact extent of the adhesion.

The blanching of the wall under a peristaltic wave in the dog's intestine indicates that temporary ischemia is normally associated with a peristaltic contraction. May not a similar diminution in blood supply, perhaps a lesser degree of it, accompany the persistent abnormal constrictions shown in Figures 6, 7 and 8? If a peristaltic contraction is superimposed, further reduction in blood supply would occur temporarily. Ischemia of the heart

muscle in coronary insufficiency and ischemia of the skeletal muscle associated with narrowing of the peripheral arteries is associated with pain. Under those conditions it has been quite well established that the pain is induced by lack of oxygen in the tissues because the pain can be relieved by measures which increase the oxygen supply in the muscle or which decrease the need for oxygen. The pain associated with peritoneal adhesions without ileus is usually cramping in character and is increased after eating. It is usually attributed to peristaltic pull of the adhesions on the sensitive peritoneum. Is it possible that ischemia in the intestinal wall at the site of the adhesion may have something to do with the pain?

SUMMARY

In the Pancoast Lecture of 1945 we have discussed the significance of certain observations on the small intestine in cases of peritoneal adhesions, obstruction and ileus. On the background of present day concepts of intestinal physiology, we have speculated on possible explanations for some of these abnormal phenomena.

Ileus is more than mere dilatation of the intestine. As ordinarily used, this term includes far-reaching disorders both within and outside of the intestinal wall.

The intestine is highly vulnerable to acute distention, but shows a remarkable ability to compensate for a gradually-developing obstruction with slow dilatation.

Hypoproteinemia and edema are frequent complications of mechanical ileus and may be responsible for a superimposed paralytic ileus.

The trouble caused by peritoneal adhesions appears to be more than the effect of mere mechanical pressure or angulation. A localized disturbance in the motor physiology of the intestine may occur at the site of an adhesion. This is manifested by narrowing of the lumen which may persist after death. The mechanism by which this is produced is not clear. Exact

knowledge concerning the histologic changes within the wall at the site of adhesions is not available. It seems possible that a mechanical stimulus from the pull of the peristaltic contraction transmitted caudad through the adhesions to the wall ahead of the peristaltic wave may play a part in causing the localized narrowing.

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REFERENCES

1. BARDEN, R. P., RAYDIN, I. S. and FRAZIER, W. D. Hypoproteinemia as factor in retardation of gastric emptying after operation of Billroth I or II types. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1937, 38, 196.
2. BAYLISS, W. M., and STARLING, E. H. The movements and innervation of the small intestine. *J. Physiol.*, 1899, 24, 99-143.
3. CHILDS, S. B., and SCUDDER, J. The effect of distention upon whole blood specific gravity and whole blood potassium. *Surg., Gynec. & Obst.*, 1941, 73, 880-884.
4. DARROW, C. W. Physiological and clinical tests of autonomic function and autonomic balance. *Physiol. Rev.*, 1942, 23, 1-36.
5. GOLDEN, ROSS. Radiologic Examination of the Small Intestine. J. B. Lippincott Co., Philadelphia, 1945.
6. INGELFINGER, FRANZ J., and MOSS, ROBERT E. The motility of the small intestine in sprue. *J. Clin. Investigation*, 1943, 22, 345-352.
7. JONES, C. M., and EATON, F. B. Postoperative nutritional edema. *Arch. Surg.*, 1933, 27, 159-177.
8. KANTOR, J. L. The roentgen diagnosis of idiopathic steatorrhea and allied conditions. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1939, 41, 758-778.
9. KING, C. E., and ARNOLD, L. The activities of the intestinal mucosal motor mechanism. *Am. J. Physiol.*, 1922-23, 59, 97-121.
10. OCHSNER, ALTON. Physiologic considerations of ileus. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1937, 37, 433-445.
11. SOPER, N. W. The roentgen ray diagnosis of lesions of the small intestine, *AM. J. ROENTGENOL. & RAD. THERAPY*, 1929, 22, 107-119.
12. STORCK, A. H., and OCHSNER, ALTON. Mechanical decompression of the intestine in treatment of ileus. II. Effect of intestinal activity. *Arch. Surg.*, 1936, 33, 670-695.
13. VON GIERKE, E. Die Geschwülste des Darmes, in Henke und Lubarsch Handbuch der speziellen pathologischen Anatomie und Histologie. Julius Springer, Berlin, 1926, Vol. IV/1, p. 1089.
14. WAELSCH, H., and RACKOW, H. Natural and synthetic inhibitors of choline esterase. *Science*, 1942, 96, 386.
15. WANGENSTEEN, OWEN H. Intestinal Obstructions. Charles C Thomas, Springfield, Illinois, 1942.
16. YOUMANS, W. B., MEEK, W. J., and HERRIN, R. C. Extrinsic and intrinsic pathways concerned with intestinal inhibition during intestinal distention. *Am. J. Physiol.*, 1938, 124, 470-477.



A PULMONARY REACTION FOLLOWING INTRA-BRONCHIAL INSTILLATION OF LIPIODOL IN BRONCHIAL ASTHMA

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EXPERIENCE has shown that the use of iodized oil in the bronchopulmonary tree may be accompanied by some danger. This has been pointed out by Amberson and Riggins,¹ who believe that a slight exudative reaction usually occurs about deposits of lipiodol in the healthy lung. They do not consider this occurrence to be harmful in the clinical sense. These authors suggest that a transudation of edema fluid may occur in considerable amount. This, they believe, may account for the rapidly developing roentgenographic lobar opacity reported by some authors following intra-bronchial instillation of iodized oil.

Sensitivity to lipiodol or its separate ingredients, however, has not been emphasized as a cause of pulmonary reaction following bronchography. Anderson² has reported on the treatment of 100 cases of bronchial asthma by intratracheal injections of lipiodol. This author mentions noting instances of certain untoward reactions following this procedure which were characterized by chest pain and temperature. Sheldon³ has reported a case of an acute pulmonary episode following instillation of lipiodol in an individual with a known allergy to iodides. A fatality has been reported by Macdonald⁴ following bronchography with lipiodol. This was the case of a thirteen year old girl who experienced nausea and vomiting after the lipiodol injection, became cyanotic, and died in twenty hours. This child had suffered from asthmatic attacks for many years and sensitization tests, carefully carried out, indicated that she was hypersensitive to several types of allergens. Macdonald believed that her death was due to an allergic reaction to lipiodol.

The importance of sensitivity to contrast media was recently reviewed compre-

hensively by Pendergrass, *et al.*⁵ who reported on a survey of unfavorable sequelae and deaths following the intravenous administration of contrast media. Although these studies were concerned principally with those contrast media in use in genitourinary diagnosis, such as diodrast, diodrast compound, iopax, neo-iopax, and skiodan, certain of these observations are pertinent to the present report. These authors postulate that the unfavorable sequelae found may be due to hypersensitivity, and that the incidence of such reactions may be greater in allergic individuals. Accordingly they point out the necessity of taking a thorough history as to personal or family allergic background, as well as performing adequate sensitivity tests in all individuals before the use of iodine-containing contrast media.

In a recent study of 40 cases of bronchial asthma, bronchograms were done as a part of a clinical investigation, using lipiodol as the contrast medium. In 3 of the cases, an acute febrile illness developed following the introduction of the medium associated with roentgen evidence of pulmonary infiltration, and certain features noted in these cases are considered worthy of reporting.

METHOD

The lipiodol used in these cases was the commercial product, consisting of iodized poppy seed oil (40 per cent), an iodide addition product of poppy seed oil containing 39 to 41 per cent of iodine (0.54 gm. of iodine per cc.) in organic combination.⁶

Butyn sulfate 2 per cent was introduced intranasally, and anesthesia of the tracheo-bronchial tree was attained by the gravity method. Lipiodol was used to visualize both lower lobes and the right middle lobe. No catheter was used to instill the lipiodol.



FIG. 1. Case 1. Routine posteroanterior roentgenogram of the chest, July 7, 1943. Negative for pulmonary pathology.

REPORT OF CASES

CASE 1. A white male, aged twenty, was admitted to the hospital July 6, 1943, with the chief complaint of wheezing and a cough. He had been a college student in civilian life, and gave a family history of two sisters and one nephew having hay fever and asthma. He had hives in childhood, his last attack occurring at the age of twelve. In August, 1941, he began to sneeze and had an acute rhinitis, with redness and watering of the eyes, cough, and tightness of the chest. These attacks lasted until the late fall. About August 1, 1942, one year later, his symptoms recurred. He entered the armed services in December, 1942. In April, 1943, he began to have wheezing which interfered with his military duties so severely that he had to be hospitalized. On admission to the hospital on July 6, 1943, many sibilant râles were heard throughout both lungs, with a prolonged expiratory phase of respiration. The remainder of the physical examination was normal. The temperature was 98.6° F. Laboratory examination revealed the Kahn test, urine, blood calcium, sedimentation rate, and gastric analysis to be within normal limits. The complete blood count was as follows: red blood cells 6.36 million; hemoglobin 19 gm.; white blood cells, 13,050; the differential was as follows: eosinophiles 20 per cent, stab cells 2 per cent; seg-

mented cells 34 per cent, lymphocytes 40 per cent, and monocytes 4 per cent.

Routine roentgenography of the chest performed on July 7, 1943, was negative for pulmonary pathology (Fig. 1).

On July 20, 1943, a bronchography was performed, the lipiodol being instilled into both lower lobes and the right middle lobe. Bronchograms of the chest following lipiodol instillation revealed a normal bronchial tree which was well outlined by the lipiodol (Fig. 2).

Nine days later on July 29, 1943, the patient complained of malaise and cough. His temperature rose to 101° F. Physical examination at this time revealed coarse moist râles at the bases of both lower lobes. The white blood count was 15,300, with the following differential: juvenile cells 1 per cent, stab cells 2 per cent, segmented cells 76 per cent, lymphocytes 21 per cent. A roentgenogram of the chest on the following day revealed a hazy density of both lower lung fields, most marked at the left base, along the cardiac border. There was also an area of patchy density in the right upper lung field (Fig. 3). An extensive urticarial rash appeared for the first time, covering both upper arms and shoulders. The urticarial lesions disappeared after twenty-four hours. His temperature rose to 102.4° F. and sulfathiazole by mouth was begun the same day. A total of 22 gm. of sulfathiazole by mouth was administered

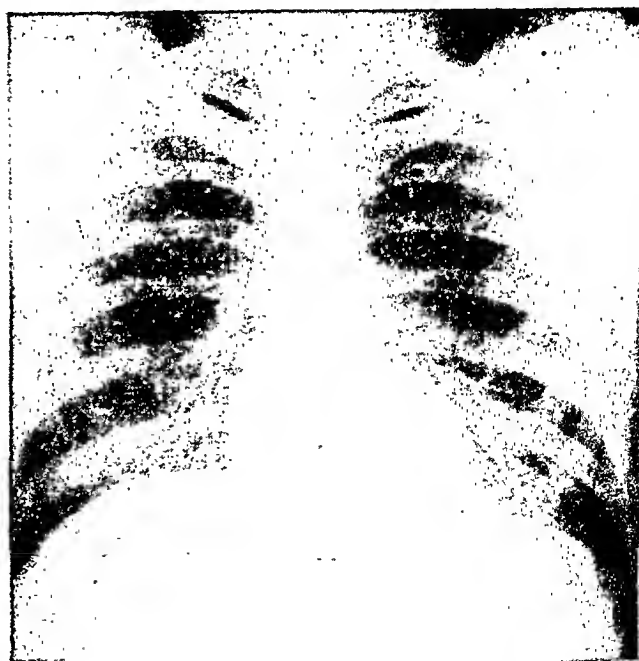


FIG. 2. Case 1. Bronchogram taken July 20, 1943, with filling of both lower lobes and the right middle lobe. Normal bronchial tree.

in the next three days. The symptoms rapidly subsided, and the temperature returned to normal after forty-eight hours. The physical signs of coarse moist râles persisted at the bases of both lower lobes and did not completely disappear until one week following the onset of the illness.

Routine roentgenograms of the chest were taken on August 6, 1943, which showed almost complete resolution of the pulmonic densities in both lung fields (Fig. 4).

Comment. This patient had a family history of hay fever and asthma. He was hospitalized because of bronchial asthma. Nine days after a normal bronchogram, he developed an acute episode characterized by a rise in temperature, cough, expectoration and malaise. An urticarial eruption appeared with the onset of this acute illness and disappeared in forty-eight hours. No eosinophilia was found. The white blood cell count was elevated. Roentgen examination of the lungs revealed bilateral basal densities, more marked on the left side. An area of patchy density was also present in the right upper lung field. The roentgen appearance suggested the presence of

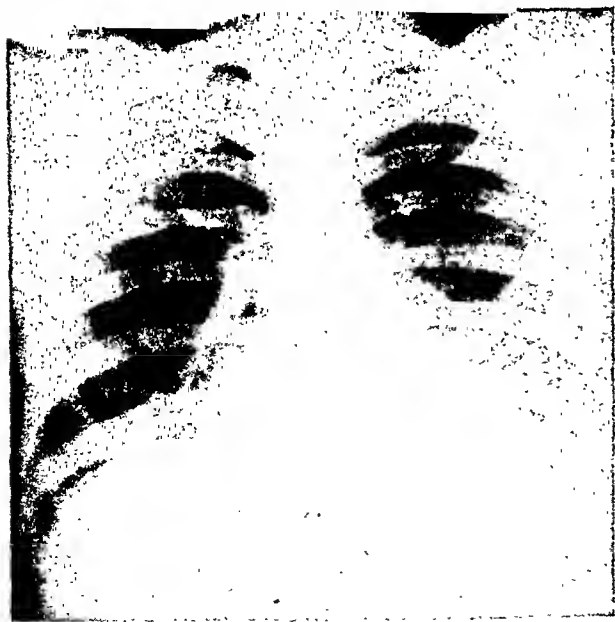


FIG. 3. Case 1. Posteroanterior roentgenogram of the chest, July 30, 1943, ten days following bronchography. Areas of increased density at both bases, more marked at the left cardiophrenic angle. Patchy area of increased density in the upper right lung field, near the upper axillary region.

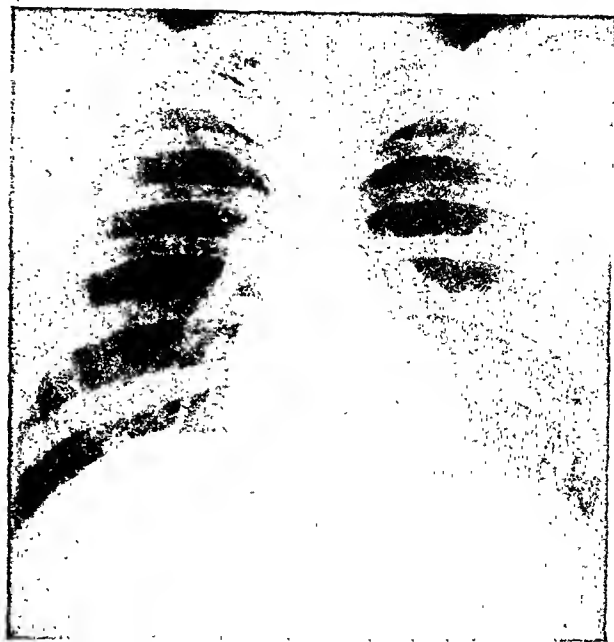


FIG. 4. Case 1. Posteroanterior roentgenogram of the chest, August 6, 1943. Almost complete disappearance of areas of increased density. Patchy infiltration still present at left base and in right upper lung field.

pneumonitis. These densities conformed to the areas of distribution of the lipiodol, except for the density in the upper right lung field. One may conjecture as to the possibility of lipiodol having been distributed to this area by coughing.

CASE II. A white male, aged twenty-one, was admitted to the hospital August 11, 1943, with the chief complaint of paroxysmal nocturnal dyspnea. In civilian life he had been a plastic moulder. A cousin suffered from asthma. He knew of no other member of the family with an allergic condition.

This patient had had dyspnea and fatigue for many years. He had been unable to engage in athletics. For two years previous to his admission to the hospital, he had noted frequent attacks of sneezing and coughing at night. He was inducted into the Army on January 28, 1943. For four months he had had paroxysmal nocturnal dyspnea, relieved by sitting upright in bed and he was hospitalized for this reason.

On admission to the hospital on August 11, 1943, physical examination revealed generalized sonorous râles throughout both lungs. Sedimentation rate, urine analysis, Kahn test, blood calcium, basal metabolic rate, gastric analysis, and stool examinations were all within normal limits. The complete blood count on August 12,

1943, showed 5.87 million red blood cells, 16.5 gm. hemoglobin, and 10,150 white blood cells, with the following differential: eosinophiles 16 per cent, stab cells 4 per cent, segmented cells 51 per cent, lymphocytes 27 per cent, and monocytes 2 per cent. A blood count taken on August 23, 1943, revealed 11,750 white blood cells with the following differential: eosinophiles 4 per cent, segmented cells 74 per cent, lymphocytes 22 per cent. Roentgenograms of the sinuses showed a pansinusitis. A routine roentgenogram of the chest taken on August 12, 1943, showed no pulmonary pathology.

Bronchography was performed on September 9, 1943, the lipiodol being instilled into both lower lobes and the right middle lobe. Bronchograms of the chest following this procedure revealed a normal bronchial tree which was well outlined by the lipiodol.

Twelve days later, on September 21, 1943, the temperature rose to 99° F. The following day, the patient complained of malaise and developed a persistent cough. The temperature continued at a level of 99.8° F. On the next day, September 23, 1943, crepitant râles were discovered for the first time at both bases, and his lips appeared cyanotic. The patient did not appear seriously ill. He raised sputum but it contained no blood. The white blood count was 22,800 with the following differential: eosinophiles 22 per cent, stab cells 5 per cent, segmented cells 50 per cent, lymphocytes 17 per cent, and monocytes 6 per cent. A roentgenogram taken on this day revealed hazy densities in both lower lung fields, more marked at the right base, where the density occupied the lower one-third of the lung field. The density at the left base was less extensive and was present at the level of the fifth and sixth ribs anteriorly, adjacent to the cardiac border.

Sulfadiazine therapy was instituted, and a total of 14 gm. was given in the next two days. On September 24, the white blood cell count fell to 18,100 with the following differential: eosinophiles 18 per cent, stab cells 7 per cent, segmented cells 54 per cent, lymphocytes 20 per cent, and monocytes 1 per cent. The following day 15,000 white blood cells were found, with the following differential: eosinophiles 27 per cent, basophiles 1 per cent, stab cells 4 per cent, segmented cells 45 per cent, lymphocytes 18 per cent, and monocytes 5 per cent. Subsequent roentgenograms taken on September 25 and 29, showed a gradual resolution of the

pneumonic densities in both lung fields. A blood count taken on the latter date showed 8,000 white blood cells, with the following differential: eosinophiles 9 per cent, segmented cells 52 per cent, lymphocytes 30 per cent, and monocytes 4 per cent. A roentgenogram taken on October 4, 1943, thirteen days following the onset of this illness, showed complete resolution in both lung fields, with residual lipiodol still present at the extreme right base and in the area in the left lung where the pulmonic density had been present.

Comment. This patient had bronchial asthma. Twelve days following a normal bronchogram, he developed an acute pulmonary episode characterized by cough, expectoration and fever. Roentgen examination of the lungs showed bilateral basal densities. A marked eosinophilia was discovered which paralleled the course of the acute illness.

In view of the extensive bilateral pneumonic densities found on roentgen examination, the temperature curve was startlingly benign. The highest temperature noted was 99.8° F., the patient in general felt quite comfortable throughout his illness, in spite of the persistence of physical signs in both lower lobes for more than a week. It was the clinical impression that the sulfadiazine had not had any particular effect on the course of the illness.

CASE III. A white male, aged thirty, was admitted to the hospital September 2, 1943, complaining of tightness in the chest and dyspnea. He had been a musician in civilian life. He stated that his mother suffered from asthma, and that he had hay fever and asthma for twenty years. He had noted an increase in the severity of his complaints during the preceding two years. He gave a long history of sensitivity to pollens and dust, and frequent attempts to desensitize had given no relief. He stated that he had never had hives. He was inducted into the Army on March 11, 1943, and was hospitalized on September 2, 1943, because of an exacerbation of his symptoms. Physical examination revealed sibilant râles heard throughout both lung fields. The sedimentation rate, Kahn, Wassermann, blood calcium, urine, gastric analysis, and basal metabolic rate were within

normal limits. A complete blood count revealed 4.7 million red blood cells, 16.2 gm. hemoglobin, and 7,050 white blood cells, with the following differential: eosinophiles 13 per cent, stab cells 2 per cent, segmented cells 67 per cent, and lymphocytes 28 per cent. A routine roentgenogram of the chest taken September 4, 1943, was negative for pulmonary pathology (Fig. 5).

Bronchography was performed September 16, 1943, with instillation of lipiodol into both lower lobes and the right middle lobe and revealed a normal bronchial tree (Fig. 6).

Two days following the bronchogram, the patient noted a sudden urticarial eruption covering the trunk and upper extremities which

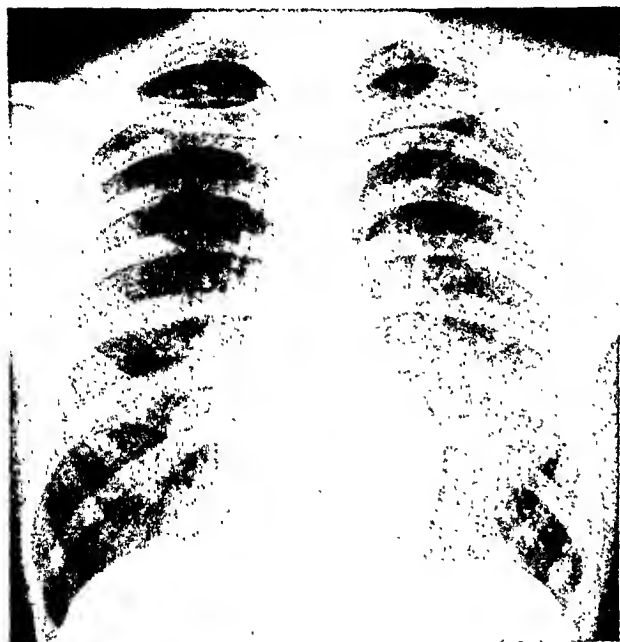


FIG. 5. Case III. Routine posteroanterior roentgenogram of the chest, September 4, 1943. Negative for pulmonary pathology.

itched markedly. This eruption disappeared within forty-eight hours. On September 24, 1943, eight days following the bronchogram, he developed a tightness in the chest which was followed the next day by chilly sensations, malaise, substernal pain, and cough. Physical examination revealed coarse moist râles over both lower lobes, in addition to the generalized sibilant râles found on previous examinations. The white blood cell count rose to 13,800 with the following differential: eosinophiles 1 per cent, juvenile cells 5 per cent, stab cells 10 per cent, segmented cells 61 per cent, lymphocytes 19 per cent, and monocytes 4 per cent. On September 25 his temperature rose to 100° F.

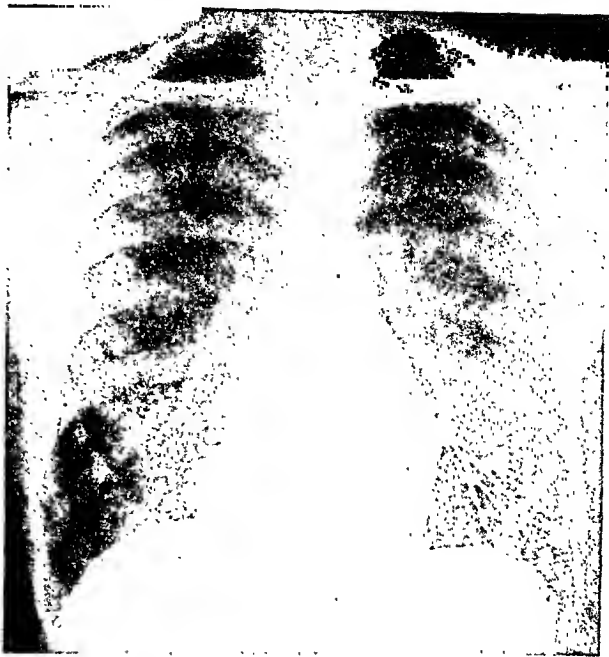


FIG. 6. Case III. Bronchogram taken September 16, 1943, with filling of both lower lobes and the right middle lobe. Normal bronchial tree.

and fell to normal on the following day. A roentgenogram taken at this time, on September 26, 1943, revealed densities of both lower lung fields which had a cotton-like appearance. The density on the left side was more marked

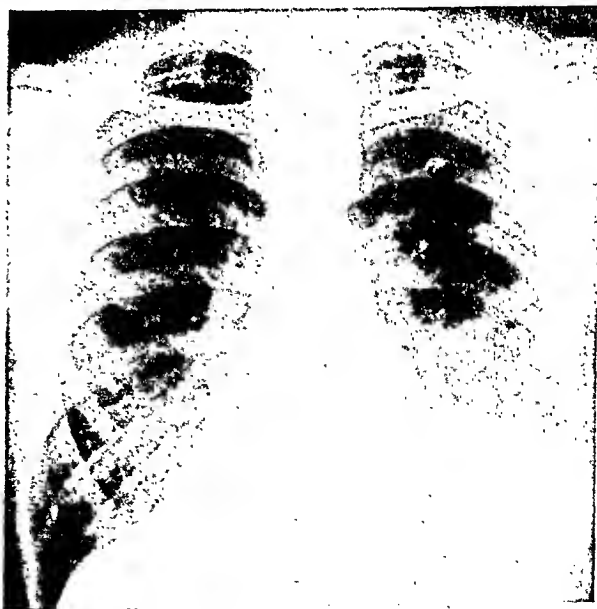


FIG. 7. Case III. Posteroanterior roentgenogram of the chest, September 26, 1943, ten days following bronchography. Areas of increased density in both lower lung fields. The density at the left base is pneumonic in character.

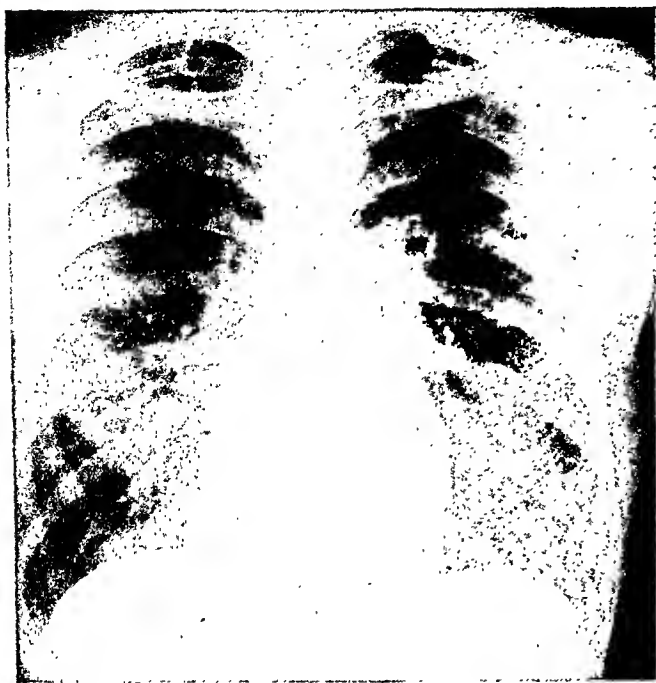


FIG. 8. Case III. Posteroanterior roentgenogram of the chest, October 4, 1943. Marked resolution of the densities seen in Figure 7. Residual lipiodol is still present in both lower lung fields.

and was pneumonic in character (Fig. 7). No sulfa drugs were given because of the experience in the two previous cases. Except for the initial temperature rise to 100° F., the patient remained afebrile and there was a complete disappearance of abnormal physical signs in both lungs after one week. A routine roentgenogram taken October 4, 1943, nine days after the onset of the illness, showed almost complete resolution of the pulmonary densities with residual lipiodol still seen in both lower lung fields (Fig. 8). A blood count taken on this day showed 8,500 white blood cells, with the following differential: eosinophiles 33 per cent, basophiles 2 per cent, stab cells 4 per cent, segmented cells 35 per cent, lymphocytes 25 per cent, and monocytes 1 per cent. On October 8 and November 1, 1943, the eosinophiles fell to 12 per cent and 2 per cent respectively.

Comment. This patient was a known asthmatic with a long history of sensitivity to pollens and dust. An urticarial eruption appeared two days after a normal bronchogram. Eight days following the bronchogram, he developed an acute pulmonary episode characterized by chilly sensations, malaise, substernal pain, and cough. Roentgen examination of the lungs revealed bilateral basal densities more marked on

the left side. Marked eosinophilia persisted during the acute illness.

The occurrence of these 3 cases within a relatively short period of time served to center interest upon certain features common to all and differing from other cases of pneumonia. It was noted that in all instances the patients were known asthmatics, that 2 of the cases had a skin eruption resembling hives following bronchography, and that all of the cases developed bilateral basal pneumonia nine, twelve and ten days respectively following that procedure. All of the cases likewise showed increases in total white blood count and polymorphonuclear neutrophils and 2 of the cases showed striking elevations in the total eosinophile count.

Because of this coincidence of findings, it was considered important to investigate the lipiodol as a possible source of the pneumonia.

Sensitivity tests were done on the 3 patients and a group of 10 control cases. The controls included several asthmatics who had had bronchography with lipiodol without apparent sequelae, as well as other patients on the chronic chest disease wards.

Various methods have been used to determine sensitivity. It was considered important to evaluate these methods of sensitivity testing and consideration was given to work which was done by Pelner⁷ and by Archer and Harris.⁸ It was determined to use the following tests for sensitivity:

1. Intra-ocular test with lipiodol.
2. Scratch test (forearm) with lipiodol.
3. Scratch test (forearm) with pure poppy seed oil (basic oil of lipiodol).
4. Intracutaneous test with diodrast, an aqueous solution of iodine in organic combination.
5. Intracutaneous test with butyn sulfate 2 per cent, the local anesthetic used in these studies.

Results. The results are summarized in Table 1.

All control cases failed to react. The 3 cases under investigation reacted only to

diodrast injected intracutaneously and Cases I and III reacted to lipiodol by scratch test. Following diodrast, Case I developed a marked erythema of the entire forearm with a large wheal and itching at the site of injection. Case III developed the same local reaction and in addition developed hives of the shoulders and neck. Following scratch tests with lipiodol, both cases developed a local wheal and itching, but the

It may be considered that the iodine portion of the lipiodol was the allergen involved, and this seemed to be borne out by the failure of these patients to react to pure poppy seed oil or butyn sulfate, the anesthetic used, and by the marked reaction produced by diodrast, an organic compound of iodine and the less marked reaction produced by the scratch test with lipiodol.

TABLE I
RESULTS OF SENSITIVITY TESTS

Sensitivity Tests	Controls (10)	Case I	Case II	Case III
Intra-ocular test: lipiodol	No reaction	No reaction	No reaction	No reaction
Scratch test: lipiodol	No reaction	Moderate reaction: local wheal, erythema, and itching	No reaction	Moderate reaction: local wheal, erythema, and itching
Scratch test: pure poppy seed oil	No reaction	No reaction	No reaction	No reaction
Intracutaneous test: diodrast	No reaction	Marked reaction: local wheal, marked erythema and itching	Moderate reaction: local wheal, and erythema; no itching	Marked reaction: large local wheal, marked erythema and itching; hives of shoulders and neck
Intracutaneous test: butyn sulfate 2%	No reaction	No reaction	No reaction	No reaction

reaction in both cases was not marked. Case II reacted to intracutaneous diodrast with a wheal, but did not react to lipiodol.

DISCUSSION

The coincidence of the development of bilateral basal pneumonia conforming anatomically to the portions of the lung fields previously instilled with lipiodol, associated with hives and eosinophilia and occurring in known cases of bronchial asthma, seemed to warrant further investigation as to possible sensitivity to lipiodol, perhaps specifically to iodine. Sensitivity tests in the cases reported and in controls seemed to incriminate the lipiodol as the agent responsible for the acute pulmonary episodes.

One may conjecture as to what exact pathological process was involved in these cases. Ellis and McKinlay⁹ have described what they term "allergic pneumonia," but in the absence of further knowledge of the pathology which these cases represent, it is felt that no attempt should be made to give any descriptive term to this type of pneumonia.

Further, why more than a week passed before the onset of pneumonia in these patients is also a matter of conjecture, although there may be a relationship between the form in which iodine is present in poppy seed oil and its ability to act as a sensitizing agent. It is noteworthy that the interval of time between instillation of lipiodol and

onset of pneumonia in these patients resembled the "delayed reaction" of serum sickness.

CONCLUSION

1. Three cases of bilateral pneumonia following intrabronchial instillation of lipiodol are presented.

2. Evidence is given which would indicate that lipiodol was the cause for the acute onset of pneumonia described.

3. The importance of skin testing in individuals, especially those with allergic backgrounds, is emphasized.

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REFERENCES

1. AMBERSON, J. B., JR., and RIGGINS, H. M. Lipiodol in bronchography; its disadvantages, dangers and uses. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1933, 30, 727-746.
2. ANDERSON, W. Some observations of the value of intratracheal injections of iodized oil for bronchial asthma. *J. Allergy*, 1932, 4, 44-47.
3. SHELDON, F. B. Long pulmonary retention of lipiodol. *Radiology*, 1943, 40, 403-404.
4. MACDONALD, I. G. Local and constitutional pathology of bronchial asthma. *Ann. Int. Med.*, 1932, 6, 253-277.
5. PENDERGRASS, E. P., CHAMBERLIN, G. W., GODFREY, E. W., and BURDICK, E. D. Survey of death and unfavorable sequelae following administration of contrast media. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1942, 48, 741-762.
6. NEW AND NON-OFFICIAL REMEDIES. *J.A.M.A.*, 1942, 305.
7. PELNER, L., Iodine allergy. *J. Lab. & Clin. Med.*, 1942, 27, 1150-1154.
8. ARCHER, V. W., and HARRIS, I. D. Ocular test for sensitivity to diodrast prior to intravenous urography. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1942, 48, 763-765.
9. ELLIS, R. V., and MCKINLAY, C. A. Allergic pneumonia. *J. Lab. & Clin. Med.*, 1941, 26, 1427-1432.



PRIMARY AMYLOIDOSIS OF THE LUNGS

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THE secondary type of amyloidosis, as it occurs in association with some chronic disease, is fairly familiar. In it amyloid is deposited most commonly in parenchymatous organs such as the liver, spleen and kidneys. The primary or atypical form, in which no antecedent condition appears to offer a background for the deposition of amyloid, is far less frequently encountered. It is more prone to affect other organs, the heart and lungs, the skin, the tongue and various mesodermal tissues. The radiological literature is particularly lacking in information on this subject, although a fair number of cases have been reported in other journals, mainly those devoted to pathology.

The characteristics which Lubarsch ascribed to the primary form have been generally accepted as criteria on which a diagnosis of atypical or primary amyloidosis, as opposed to the secondary type, may be based. These have been quoted repeatedly in the literature and are as follows:

1. Almost complete absence of amyloid in organs most involved in typical amyloidosis such as spleen, liver and kidneys.
2. Presence of amyloid in organs and parts not usually involved, such as heart, lungs and skin.
3. The occasional occurrence of tumor-like nodules of amyloidosis.
4. The frequent failure of the deposits to react to the specific stains for amyloidosis.
5. The absence of a preceding or concomitant disease to which the presence of amyloidosis may be ascribed.

Individual cases cannot always be so easily placed in one of these two categories, however. For instance amyloid deposits which occasionally are found in association with multiple myeloma may show a distribution more characteristic of the primary than of the secondary type. To meet such

contingencies Reimann, Koucky and Eklund proposed the following classification of amyloidosis:

1. Primary.
2. Secondary.
3. Amyloidosis associated with multiple myeloma.
4. Tumor forming amyloidosis.

They further subdivided primary amyloidosis into a systemic type, a generalized disease of the mesoderm, and a localized variety, in which one or two organs in particular are involved. The case here presented falls into this latter group. Simplicity is perhaps better served by retaining the earlier classification into two forms.

CASE REPORT

The patient, a white male physician, aged sixty, first visited the Department of Radiology of St. Francis Hospital as an out patient in April and May, 1941, with a history of some indefinite abdominal discomfort and diarrhea, and a beginning dyspnea and ease of fatigue. He had had a mild pyelitis in 1934 which had promptly cleared. There were no urinary symptoms at this time but a few red blood cells were found in a centrifuged urine specimen. An excretory pyelogram was done with negative findings. Soon thereafter a roentgen examination of the entire gastrointestinal tract also showed normal findings. Roentgenoscopic and roentgenographic chest examination (Fig. 1) demonstrated a slight enlargement of the left lower part of the cardiac shadow, a slight diffuse aortic enlargement and some accentuation of the bronchovascular shadows in the inferior part of each lung considered to be due to slight peritruncal fibrosis.

In December, 1941 he developed an acute respiratory infection which bore some clinical characteristics of an atypical pneumonia: fever, malaise, cough and pain in the left chest. He recovered sufficiently to resume some work eighteen days later but his convalescence was delayed by weakness, dyspnea and some pre-



FIG. 1. May 8, 1941. Slight cardiac and aortic enlargement. Moderate enlargement of left and lower right hilar shadows. Early peritruncal fibrosis of lower parts of both lungs. Emphysematous bullae right apex.

mature heart beats. Roentgenograms of the chest on December 20, 1941 (Fig. 2 and 3) showed an increase in the parenchymal shadows plus a left basilar pleuritis. An electrocardiogram showed a lower potential in all leads than

previous tracings. Previous electrocardiograms had been made following a transient attack of paroxysmal auricular fibrillation in 1937. An eminent cardiologist was consulted who believed that the condition was probably a mild cardiac weakness due to "progressive narrowing of his coronary arteries" (or occlusion lenta). He advised a few month's rest. This advice was followed and digitalis used with no further clinical improvement.

A roentgenogram on January 9, 1942, showed slight improvement, mainly in the signs of pleuritis (Fig. 4). The patient then spent two months at rest in Tucson, Arizona, where additional studies were made (Fig. 5). These and others of April 17 and May 22, 1942, after his return, revealed an increase in the linear and nodular shadows in both lungs. Thereupon the concept of a pulmonary congestion on a cardiac basis, which had been given some consideration, was abandoned. The roentgen diagnosis was a diffuse pulmonary fibrosis of undetermined etiology and a left pleuritis. Throughout this period dyspnea was the predominant symptom, associated with weakness and left chest pain. The patient denied any exposure to harmful dusts on specific questioning (Fig. 6 and 7).

The possibility of a pulmonary sarcoidosis was considered and when a cervical adenopathy developed a few months later a gland was removed for biopsy. It showed a type of fibrosis considered suggestive but not characteristic



FIG. 2. December 20, 1941. Left basilar pleuritis. Increased diffuse pulmonary and hilar fibrosis.



FIG. 3. December 20, 1941. Lateral projection. Obliteration of posterior sulcus.



FIG. 4. January 9, 1942. Slight improvement in left pleuritis. Little change in lung parenchyma (heavier exposure).

of that disease. Unfortunately, no specific stain for amyloid was employed. The history and the roentgenographic and pathologic findings were reviewed by several prominent radiologists and internists and, although none ventured a positive diagnosis, the consensus favored Boeck's sarcoid.

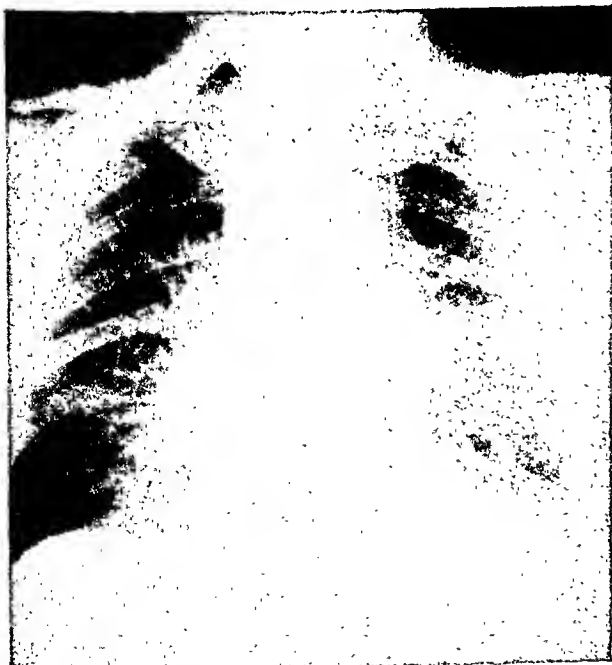


FIG. 6. May 22, 1942. Beginning atelectasis of left lower lobe.

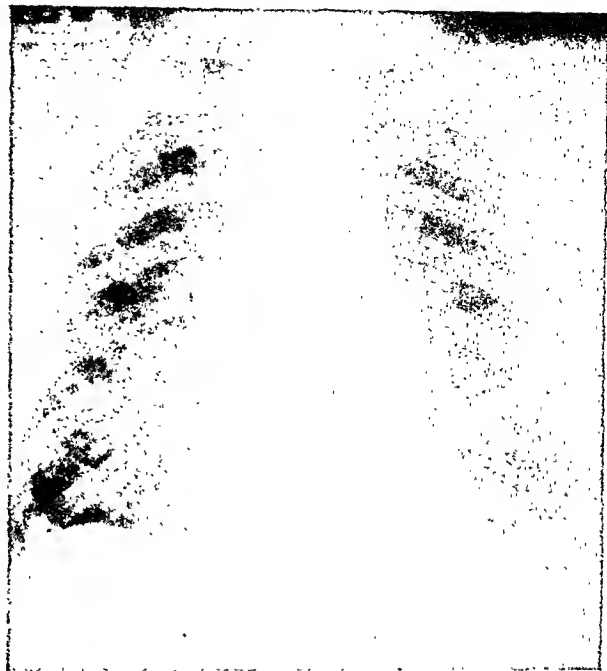


FIG. 5. February 23, 1942. Increased linear and nodular shadows throughout both lungs. Further hilar enlargement. (Courtesy of Tucson Clinic, Tucson, Arizona.)

Since two radiologists suggested roentgen therapy to the chest on the basis of that tentative diagnosis and because of a reported favorable response of two or three recent cases to that agent (not published), such treatment was

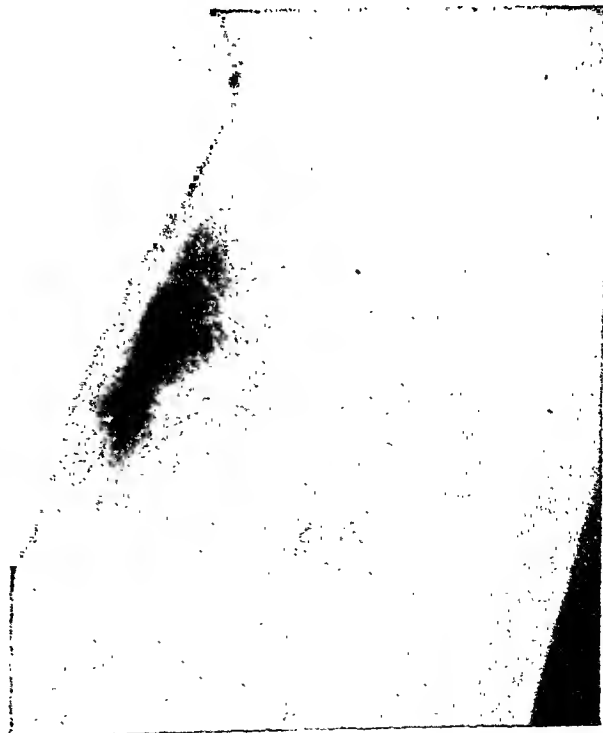


FIG. 7. Lateral projection, same date.



FIG. 8. November 7, 1942. Atelectasis left lower lobe. Slight right, moderate left pleural effusions. Increased hilar, mediastinal and pulmonary fibrosis. Probable pulmonary vascular congestion superimposed.

instituted on November 7, 1942. On that date a roentgenogram showed a further increase in the pulmonary fibrosis, an increase in the left pleuritis along with some atelectasis, and a small bilateral pleural effusion (Fig. 8). Using 200 kilovolts, 10 milliamperes, a 0.5 mm. copper filter, and a target-skin distance of 50 cm., a total of about 1,200 roentgens, measured in air, was delivered to each of four areas, two anterior and two posterior, over the chest. With the same technique 600 r was given to the left chest laterally and 300 r to the lateral part of the right chest. One dose of 200 r was given to each side of the neck. The treatments were usually given at two or three day intervals.

After an apparent slight initial response the patient gradually and progressively became worse. Treatments were discontinued December 1, 1942, and the patient died on January 23, 1943. The last few months were marked by a progressive orthopnea, an unproductive cough and an increasing edema of the lower extremities.

Blood findings were inconclusive. There was a constant leukocytosis of 10,000 to 15,000 cells per cu. mm. from 1934, when it was first discovered, until shortly before the patient's death, when it fell to 6,400. The differential count was

usually normal with an occasional lymphocytosis.

Postmortem Examination

Anatomical Diagnoses: (1) primary amyloidosis of lungs, lymph nodes and spleen; (2) hypertrophy of both ventricles and right atrium; (3) generalized atherosclerosis of aorta and peripheral arteries; (4) bilateral hydrothorax and anasarca of both feet and legs; (5) atelectasis of lower lobe of left lung; (6) calcified primary tuberculous complex in lungs and regional lymph nodes; (7) bullous emphysema of right upper lobe of lung; (8) circumscribed left adhesive pleurisy; (9) multiple subserous hemorrhages in the small intestine.

Gross Examination.

The body was that of a moderately well nourished white male of medium size. The skin showed no pathological lesions. There was a definite edema of both feet and the lower halves of the legs. The cervical, axillary and external inguinal lymph nodes were enlarged up to the size of a hazelnut. On opening the abdomen there was no free fluid present. The small intestine was contracted, apparently empty and there were many subserous hemorrhages regularly scattered over the bowel, each being about the size of a tapioca grain.

On opening the chest it became evident that the ribs and the sternum showed a considerable degree of osteoporosis. In both pleural cavities, particularly the left, there was a large amount of clear amber serous fluid amounting to about 3 pints. Both lungs were conspicuous by their dark color, particularly revealed on the surface. The pleura was slightly thickened in some places but not adherent to the chest wall except at the left lower lobe which was fixed to the parietal pleura by one string-like adhesion of the thickness of a pencil. The left lower lobe was completely airless. All lobes of the lungs showed a striking increase in consistency due to the presence of indurated areas, either in the form of small ill defined nodules or strands, black stained by anthracosis. In the apex of the right upper lobe, the lung showed a few thin-walled cavities up to the size of a hazelnut, very closely compacted, as seen in bullous emphysema. The bronchial tree was opened and no tumor was found. The mucosa was reddened and covered with mucus. All bronchomediastinal lymph nodes were enlarged up to the size of a pigeon's egg, black by anthracosis, hard in consistency

with a waxy, dull lustre on the cut surface and imbedded in heavy scar tissue. This scar tissue was amalgamated to the trachea, main bronchi and the large blood vessels. All these structures composed a mass strikingly rubbery in consistency. A calcified area the size of a cherry seed was found in the right lower lobe and calcium deposits in some lower tracheobronchial lymph nodes.

The heart was enlarged, due to hypertrophy of both ventricles. The wall of the right ventricle particularly was much thickened. The mitral valve showed a flat area of thickening particularly in the posterior cusp characterized by a rough, almost verrucous relief and hard consistency.

The liver was normal in size, but the markings indicated passive congestion and probably some fatty infiltration. The gallbladder and bile duct system were negative.

The spleen was large, at least twice normal size, firm in consistency and dark red, showing obscured markings on the cut surface and a dull lustre as seen in diffuse amyloidosis. Scattered through the red pulp were many calcified nodules, round in shape, the largest about the size of a peppercorn.

The adrenals were large, almost double the size of normal adrenals. The cortex was thickened and diffuse yellow.

The kidneys were essentially negative.



FIG. 9. Photomicrograph showing severe amyloidosis of blood vessel wall and of supporting fibrous and adipose tissue.

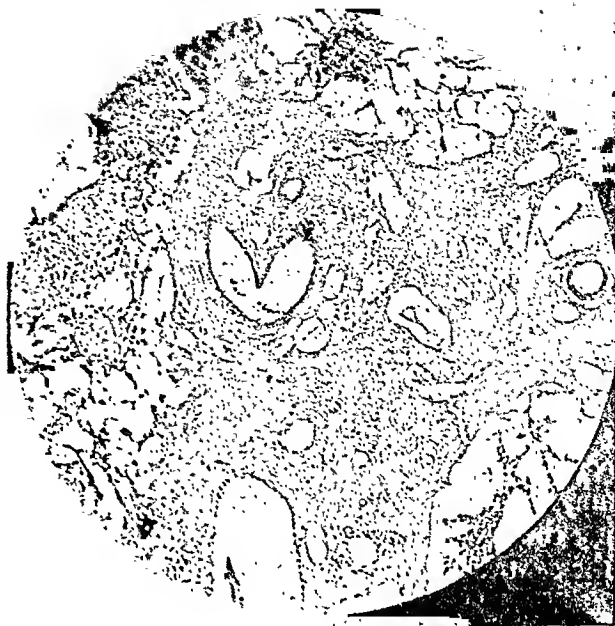


FIG. 10. Photomicrograph showing mediastinal lymph node structure largely replaced by fibrous tissue infiltrated by amyloid.

The abdominal and pelvic lymph nodes were all enlarged to varying degrees, the largest attaining the size of a pigeon's egg. They were rubbery in consistency and striking by the dull, waxy lustre of the cut surface. On touching the cut surface slightly one had somewhat the sensation of fine sand. The color of the lymph nodes on cross section was partly pinkish, partly grayish-white. There was no normal marking discernible on the cut surface. The fat tissue surrounding these lymph nodes also was indurated.

The intestinal canal did not show essential changes except the subserous hemorrhages mentioned above.

Histological Examination

Lung: The alveolar walls and lung septa are thickened due to deposits of amyloid. The walls of blood vessels are filled with amyloid. There are many "heart failure" cells and many deposits of anthracotic pigment.

Mediastinal Connective Tissue: Sections show an almost solid infiltration by amyloid (Fig. 9).

Lymph Nodes: The normal structure is almost gone due to large deposits of amyloid (Fig. 10).

Jejunum: There is a small circumscribed deposit of amyloid in the submucosa.

Spleen: There is an almost diffuse deposition of amyloid throughout the red pulp. The follicles are atrophic and apparently without

amyloid. The walls of the blood vessels also contain amyloid.

Heart: In some parts there is much fibrosis which contains amyloid. The muscle fibers are hypertrophic and show fatty degeneration. There is much lipofuscin at either pole of the muscle nuclei. Sections of a thickened valve (mitral) show deposits of amyloid and much fibrous tissue. There are small deposits of amyloid on the inner surface of the pericardial sac.

Kidney: No amyloid.

Liver: No amyloid.

Adrenal: There is much lipid present in the cortex and it is evenly distributed. There are amyloid deposits in the fibrous tissue surrounding the cortex. There is amyloid in the walls of the central adrenal vein.*

DISCUSSION

Primary amyloidosis is a very uncommon disease. For this reason and because the symptomatology is so varied, depending upon the location of the amyloid deposits, the diagnosis has rarely been made clinically.

The tongue is a frequent site of involvement and here the condition results in an enlargement of the tongue which simulates cancer. Dyspnea is a very prominent feature of pulmonary amyloidosis but of course it is a very common symptom in many diseases. Extensive amyloid deposits in the heart may lead to cardiac failure, which also results in dyspnea, and again amyloid tumors of the larynx or trachea will produce a form of dyspnea. Purpuric types of hemorrhage have been described occurring in the skin and the mucous membranes, as well as hematemesis, melena and hematuria. Such bleeding has been ascribed to vascular infiltrations. However, amyloid deposits in the walls of blood vessels, especially the smaller arteries and veins, is a very common finding in this disease but bleeding is seldom reported.

Gastrointestinal deposits may also result in either constipation or diarrhea, abdominal pain or vomiting. The case history here

recorded includes a complaint of abdominal distress and at least one period of mild diarrhea but there was no gastrointestinal amyloid except one small deposit in the jejunum. Primary involvement of bone is rare. One case has been reported in which a pathological fracture of the neck of the femur occurred. Deposits in muscles, tendons and joint capsules have been more frequent and have caused the symptoms of stiffness, painful motion of extremities, back pain and difficulty in walking.

A considerable number of skin lesions have been described. These have been lichenoid lesions and plaque-like hyperkeratoses varying from pink to yellow or light brown and to a normal color. Even where such lesions were biopsied the true diagnosis was not established in more than one instance, to be arrived at during subsequent autopsy. This has been due to atypical staining reactions or, more likely, to failure to employ a specific stain for amyloid.

Peripheral nerve infiltrations have been recorded specifically in 2 cases, resulting in a progressive muscular weakness. Primary systemic amyloid, as the name implies, involves many organs and hence produces a variety of symptoms. Even the localized type, not including a few local amyloid tumors, show slight disseminated amyloid deposits in addition to the primary involvement of one or two organs. It is easily understood, therefore, why the clinical diagnosis of this disease is so rarely made. It is quite possible, however, that with increasing awareness of the possibilities of this condition, and with more widespread use of the biopsy and the Congo red test the condition may be more commonly recognized in the living patient.

Whether roentgenography will contribute materially to our success in evaluating these cases correctly antemortem remains to be demonstrated. So few observations are yet available that it is impossible to establish any positive diagnostic criteria or to do more than relate the few findings of individual cases.

* I wish to express appreciation to the pathologist, Dr. J. E. Kraus, for pathological diagnoses and descriptions and other assistance.

Several descriptions of roentgenographic findings in gastrointestinal amyloidosis are available. Lubarsch* in 1929 mentioned that one case having amyloid deposits in the gastric musculature showed roentgen signs of a pyloric stenosis and was diagnosed a carcinoma of the pylorus. Another case showed only a disturbance in the passage of the opaque meal through the stomach. Clausen* in 1935 described a narrowing of the prepyloric canal 2 cm. long and 1 cm. in diameter. Proximal to this there was increased peristalsis. The pylorus and duodenal bulb were normal and there was no delay in emptying. A diagnosis of an infiltrative process of the gastric wall, probably scarring or tumor, was made. Autopsy revealed extensive amyloid degeneration of the musculature and microscopic deposits in the mucosa. Heeren described a colonic lesion, apparently of the secondary type. This showed irregular jagged contours of the sigmoid, descending and transverse colon and a slight narrowing of the lumen when distended. A postevacuation roentgenogram showed an irregular, widened mucosal pattern. An air injection study revealed some haustral folds and only slightly less than normal flexibility. These characteristics the considered distinguishable from those of an ulcerative colitis, which it resembled. He stated that an increase in the size of the lumen could be expected in a late stage in contrast to the narrowing of colitis.

Few reports of bone and joint lesions have appeared. Lengh described involvement of several joints in a case of generalized amyloidosis which he thought secondary to chronic pyelitis. The carpal bones showed a spotty osteoporosis with smooth contours. There were bean-sized, faintly opaque shadows in the soft tissues of the wrist and knee which proved to be amyloid deposits containing calcification. Several of these were free in the joint space.

Koletsky and Stecher, in reporting a case of the primary systemic type, reproduced a roentgenogram showing a pathological frac-

ture of the femoral neck with considerable fragmentation and absorption of bone. Other roentgenograms of the same case were reported to show a general demineralization of both hands, one knee and one shoulder. There was fragmentation about the greater tuberosity and a slight downward displacement of the head of the humerus. Clinically these joints showed a firm, irregular, non-tender enlargement. At autopsy a very large mass of amyloid was discovered replacing the bone of the neck of the femur and extending into surrounding tissue.

Very few cases of pulmonary involvement of significant degree are reported and in at least 2 such cases no roentgenograms were made. A few instances of microscopic amounts of amyloid in the lungs are reported with negative roentgenographic findings. Nevertheless, there is a consistency in the few positive findings available that may be significant. Sappington, *et al.* have recently reported a case of primary amyloidosis of the lungs with the following roentgenographic findings: "... some enlargement of the cardiovascular silhouette, and the lung fields were indefinitely hazy." Michelson and Lynch presented a case of systemic primary amyloidosis with marked involvement of the lungs and mediastinum. A roentgen examination of the chest is reported to have shown a slight bilateral pleural effusion and "a diffuse infiltration throughout both lungs following the bronchovascular trees and suggesting some type of pulmonary congestion of rather extreme degree or an infiltrating process. There was a large mass in the region of the right hilum." This roentgenogram was reproduced and shows considerable similarity to those of our case, as do the respective pathological findings within the chest. In that case a roentgenogram less than two years before was reported negative.

In the case here reported the first roentgenogram, twenty months before death, already showed some bilateral enlargement of the hilar shadows and a linear and finely

* As quoted by Heeren.¹⁴

nodular peritruncal infiltration widely disseminated in the parenchyma of the lungs. Seven months later these findings were intensified considerably. At that time a left basilar pleuritis developed, but this was thought to have improved slightly two months later (February 23, 1942). One year after the first examination (May 22, 1942) a gradual progression of the hilar and parenchymal fibrosis was shown but by then some atelectasis of the left posterior lung base had developed. This slowly increased during the remaining eight months of life. The last roentgenogram, over two months before death, revealed all of these characteristics much increased in degree and extent, but apparently complicated by beginning heart failure. There was also increased density and loss of sharp outline of the superior mediastinal shadow reflecting the severe fibrosis of the mediastinum within which were discovered many amyloid deposits.

It is possible to reconstruct from these roentgenographic changes, in the light of the autopsy findings, the gradually progressive deposition of fibrous tissue and amyloid material in the lungs, hila and mediastinum over a period of certainly more than twenty months. The fact that bed rest and digitalis had no effect on its course served to distinguish it from a pulmonary congestion and edema from cardiac decompensation. A careful history eliminated the possibility of a pneumoconiosis. The similarity to a pulmonary sarcoidosis was striking. In such cases the use of a biopsy, if material is available, and the Congo red test should permit differentiation when the possibility of a primary amyloidosis is kept in mind, as it was not in this instance. The unremitting retrogressive course has been characteristic of all cases of this disease.

CONCLUSIONS

1. The report of a case of primary amyloidosis involving primarily the lungs, mediastinum, lymph nodes and spleen is added to the slowly growing list of such cases.

2. Roentgenographic characteristics of the intrathoracic form of this condition in this case are described, with a review of roentgen findings previously recorded in these and other organs.

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REFERENCES

1. ABRAMOWITZ, E. W., and ISAAK, L. Lichenoid amyloidosis. *Arch. Dermat. & Syph.*, 1939, 40, 13-18.
2. BANNICK, E. G. Diffuse amyloidosis of unknown etiology. *Med. Clin. North America*, 1934, 18, 413-418.
3. BANNICK, E. G., BERKMAN, J. M., and BEAVER, D. C. Diffuse amyloidosis. *Arch. Int. Med.*, 1933, 51, 978-990.
4. BEAVIS, J. O. Local amyloid disease of upper air passages. *Arch. Otolaryng.*, 1934, 19, 439-450.
5. BINFORD, C. H. Primary amyloid disease of the myocardium and blood vessels. *Arch. Path.*, 1940, 29, 314-320.
6. BUDD, J. W. Primary amyloid disease of the heart. *Am. J. Path.*, 1934, 10, 299-308.
7. CLERF, L. H. Amyloid tumor of larynx. *Arch. Otolaryng.*, 1942, 36, 377-380.
8. DE NAVASQUEZ, S., and TREBLE, H. A. Primary generalized amyloid disease with involvement of the nerves. *Brain*, 1938, 61, 116-128.
9. DILLON, J. A., and EVANS, L. R. Primary amyloidosis. *Ann. Int. Med.*, 1942, 17, 722-731.
10. DOSTROVSKY, A., and SAGHER, F. Localized amyloidosis of skin. *Arch. Dermat. & Syph.*, 1941, 44, 891-906.
11. FELLER, A. Amyloidose der Gelenke. *Centralbl. f. allg. Path.*, 1935, 63, 123. (abs.).
12. FIGI, F. A. Excision of amyloid tumor of larynx and skin graft. *Proc. Staff Meet., Mayo Clin.*, 1942, 17, 239-240.
13. FOWLER, W. M. Idiopathic amyloidosis. *J. Iowa M. Soc.*, 1936, 26, 98-100.
14. HEEREN, J. G. Das Röntgenbild der Amyloidose des Dickdarms. *Röntgenpraxis*, 1941, 13, 176-178.
15. KERNOHAN, J. W., and WOLTMAN, H. W. Amyloid neuritis. *Arch. Neurol. & Psychiat.*, 1942, 47, 132-140.
16. KERWIN, A. J. Idiopathic amyloid disease of the heart. *J. Lab. & Clin. Med.*, 1936, 22, 255-261.
17. KOLETSEY, S., and STECHER, R. M. Primary systemic amyloidosis. *Arch. Path.*, 1939, 27, 267-288.
18. KRAMER, R., and SOM, M. L. Local tumor-like deposits of amyloid in larynx. *Arch. Otolaryng.*, 1935, 24, 324-334.

19. LARSEN, R. M. Pathological study of primary myocardial amyloidosis. *Am. J. Path.*, 1930, 6, 147-160.
20. LENGH, F. Zur Kenntnis der Amyloidablagerung in den Gelenken. *Zentralbl. f. allg. Path. u. path. Anat.*, 1937, 69, 1-5.
21. MICHELSON, H. E., and LYNCH, F. W. Systematized amyloidosis of skin and muscles. *Arch. Dermat. & Syph.*, 1935, 32, 363-369.
22. MOSHCOWITZ, E. Primary amyloidosis. *J. Mt. Sinai Hosp.*, 1935, 2, 14-16.
23. PEARSON, B., RICE, M. M., and DICKENS, K. L. Primary systemic amyloidosis. *Arch. Path.*, 1941, 32, 1-10.
24. REIMANN, H. A., KOUCKY, R. F., and EKLUND, C. M. Primary amyloidosis limited to tissue of mesodermal origin. *Am. J. Path.*, 1935, 11, 977-988.
25. ROSENBLUM, A. H., and KIRSHBAUM, J. D. Multiple myelomas with tumor-like amyloidosis. *J. A. M. A.*, 1936, 106, 988-991.
26. SAPPINGTON, S. W., DAVIE, J. H., and HORNEFF, J. A. Primary amyloidosis of the lungs. *J. Lab. & Clin. Med.*, 1942, 27, 882-889.
27. WARREN, S. Generalized amyloidosis of the muscular systems. *Am. J. Path.*, 1930, 6, 161-168.
28. WINER, L. H. Local amyloidosis of the skin. *Arch. Dermat. & Syph.*, 1931, 23, 866-871.



THE ROENTGEN DEMONSTRATION OF AN ABERRANT PANCREATIC NODULE IN THE STOMACH

REPORT OF THREE CASES

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ANOMALOUS formation of the pancreas, though by no means common, is far from rare. The anomalies may take one or more of the following forms:

1. Separation of the part of the head known as the uncinata process, which then forms a lesser pancreas.

2. A growth of the pancreas around the duodenum which it may encircle for a short part of its course (annular pancreas).

3. Variations at the termination of the main pancreatic duct: (a) partial or (b) non-joining with the common bile duct.

4. Displacement of the main pancreatic duct termination by a congenital diverticulum of the duodenum near the ampulla of Vater.

5. Accessory or aberrant pancreas. It is this last anomaly to which this report is devoted.

Accessory glands (accessory or aberrant pancreas) appear as rounded, flattened tumors varying in size up to 4 cm. They may be single or multiple. They may occur anywhere in the stomach, small bowel, mesentery, or omentum. They have been found within duodenal or Meckel's diverticula. They may have independent excretory ducts sometimes opening on papillary elevations. They seldom contain islands of Langerhans, but if present they are usually deformed. Small myomas (adenomyomas) may develop around aberrant pancreatic nodules.

Most pathologists and embryologists are of the opinion that these pancreatic nodules may occur anywhere in the stomach, small bowel, mesentery, or omentum, corresponding to the primitive anlage of the pancreas. They develop in the form of

single or multiple small cell rests. In 1934 King and MacCallum proposed that adult tissue, namely the intestinal epithelium, could retain its metaplastic powers so prevalent in the embryonic stage. In this way they believed that they could explain the presence of aberrant pancreatic tissue. They offered several plausible, though not conclusive, reasons to substantiate their views. This hypothesis, though apparently little accepted, does offer interesting speculation.

The demonstration of aberrant pancreatic tissue in the gastrointestinal tract has been recorded in the literature for a great number of years, so that at the present time there are over 300 individual cases on record. For the most part these have been discovered as incidental findings at autopsy.

In 1924 Vigi and Gamberini, after studying numerous pathological specimens, predicted that aberrant pancreatic tissue could be demonstrated roentgenologically during life and they went further to describe what they believed would be the characteristic findings. These, however, are not pathognomonic. Since then a definite abnormality has been noted on roentgen examination of the gastrointestinal tract by Branch and Gross, King and MacCallum, Faust and Mudgett, and others. In no case was the true histopathological nature of the lesion diagnosed prior to operation or autopsy. In most instances the roentgen diagnosis was carcinoma.

A careful search of the American and British roentgenological literature discloses that very little has been written on this

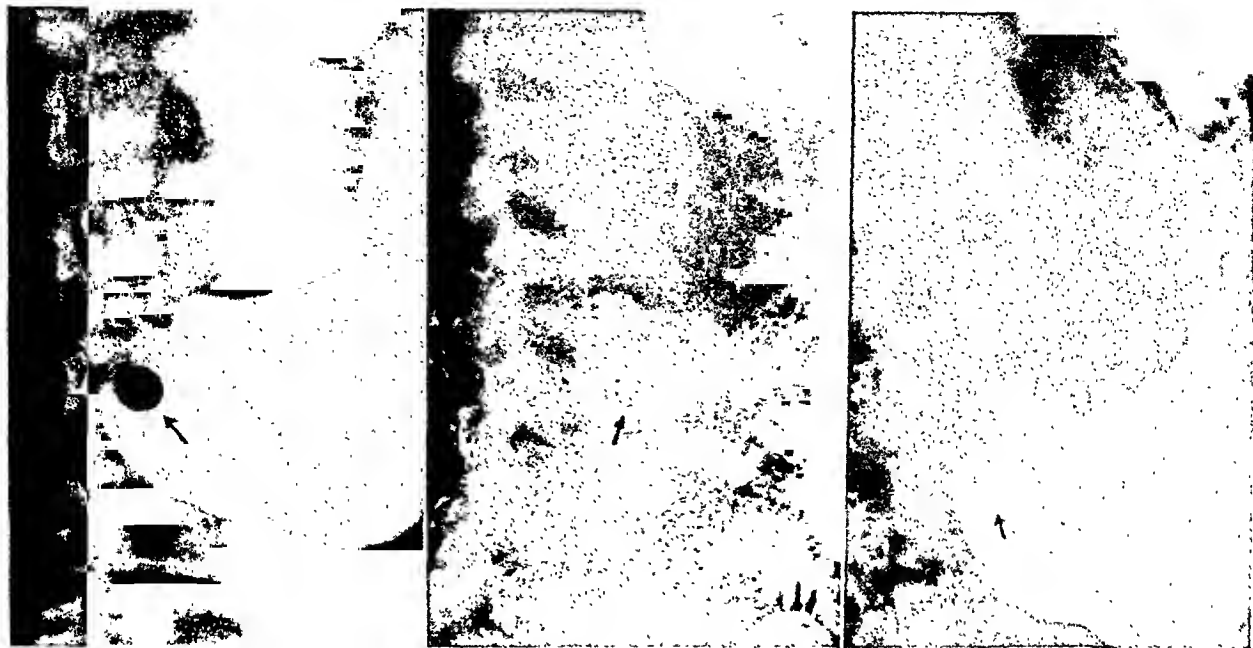


FIG. 1. Case 1. Roentgenograms showing the 1.5 cm. spherical defect.

interesting subject. It was therefore believed desirable to record the following cases, especially so because the illustrations depict the anomaly very clearly.

CASE REPORTS

CASE 1. The patient was a white male, aged thirty-one, who had no complaints until approximately ten months ago. At that time he began to notice gnawing pain in the epigastrium which usually occurred twenty to thirty minutes after meals. This pain was easily relieved by the ingestion of milk. Recently the pain became sufficiently severe to awaken him at night. There was occasional vomiting but no hematemesis or melena. There was a concomitant weight loss of 14 pounds.

The physical examination was negative except for the abdomen. This was flat and showed no masses. The liver, kidneys and spleen were not palpable. There was tenderness in the mid-epigastrium with the maximum point 2 to 3 cm. to the left of the midline.

A gastrointestinal roentgen examination revealed a partially obstructing duodenal ulcer. As an incidental finding a spherical polypoidal mass 1.5 cm. in diameter was noted in the pylorus, just proximal to the pyloric sphincter on the anterior wall. The mass was constant in size, its borders were smooth and it rested on a flat sessile base. The general and local contour and function of the stomach were unaf-

fected.

A few days later a second roentgen examination was performed. The findings were identical with those of the first.

A week later a gastric resection was done removing the distal 60 per cent of the stomach. This included the mass noted in the roentgen examinations.

Pathological Report. Gross description. The specimen consisted of a segment of stomach, previously opened along the lesser curvature. The serosa was smooth, pale and intact. The wall was of normal thickness. On the anterior wall there was a cylindrical tumor mass measuring 1.5 cm. in diameter which projected into the lumen of the stomach. The overlying mucosa was intact. Its center was slightly umbilicated. The mass was freely movable and apparently attached to the muscularis. The gastric mucosa elsewhere was normal. Microscopic description: the mucosa over the tumor mass was thinned but intact and heavily infiltrated with lymphocytes. In the mucosa and submucosa were small collections of glandular structures separated from one another by fibrotic bands of variable thickness. These acini were small, regular, and lined by pyramidal cells. The lumina were often indistinct or completely lacking. Occasionally associated with these acini were small ducts lined by a single layer of columnar cells. No connection between the ducts and acini was discerned. Elsewhere,

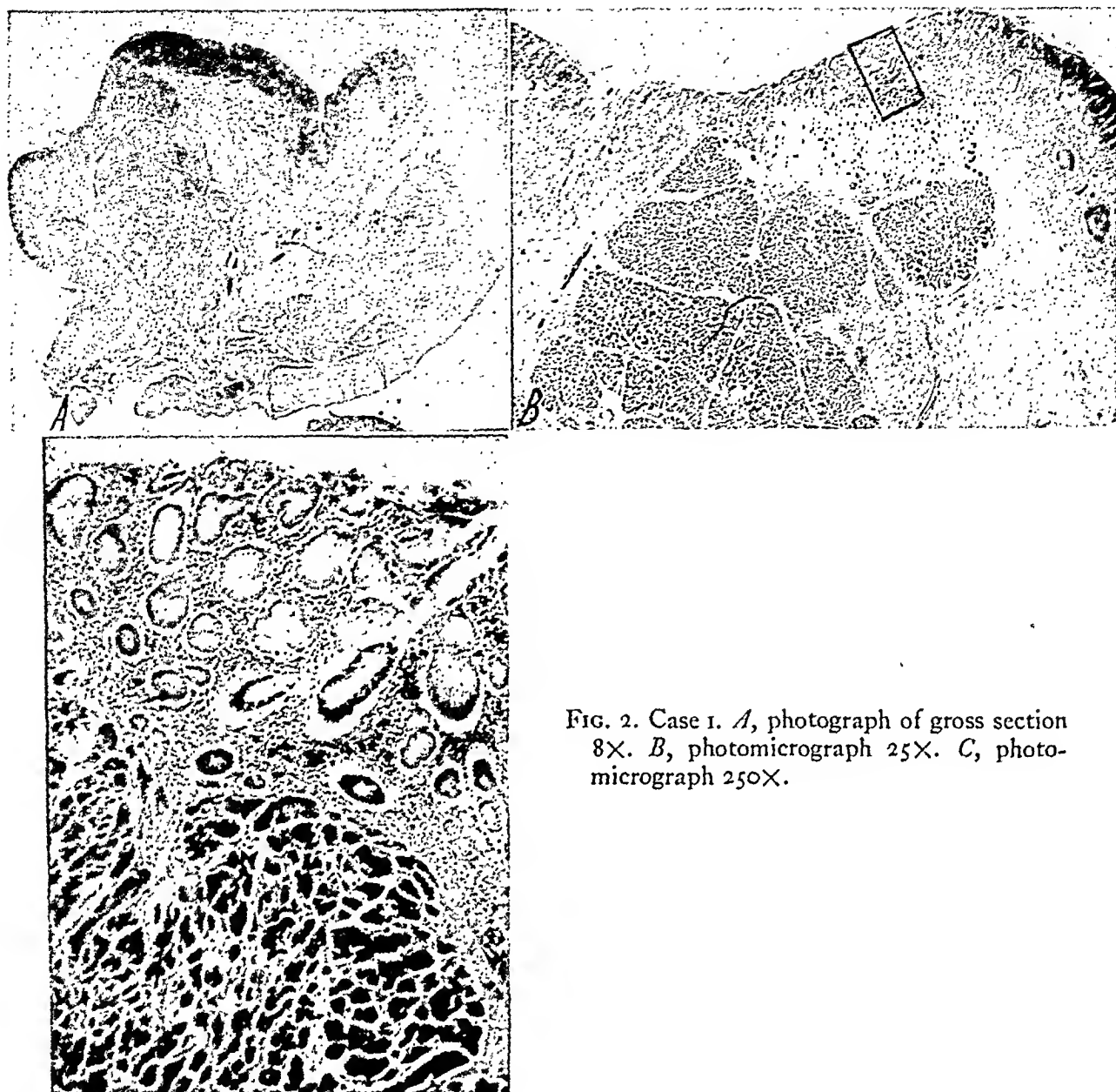


FIG. 2. Case 1. *A*, photograph of gross section 8X. *B*, photomicrograph 25X. *C*, photomicrograph 250X.

there were groups of larger, irregular similar ducts surrounded by clusters of typical mucous glands whose mucin failed to stain by either the Mallory-eosin, methylene blue method or Masson's trichrome stain. An occasional goblet cell was noted in the lining epithelium of some of the ductal structures. Although the glandular foci were confined chiefly to the submucosa, some were found in the mucosa and in the muscularis. The histopathological picture was characteristic of pancreatic tissue. No islands of Langerhans were found. There was no evidence of cellular proliferation. Microscopic diagnosis: Aberrant pancreatic rest of stomach.

CASE II. Patient was a male, aged fifty-five, who had a two year history of epigastric dis-

gastric discomfort which was relieved by food. There had been a 20 pound weight loss in one year. Physical examination was negative.

Gastrointestinal roentgen examination revealed a scar-deformed duodenal bulb with no direct evidence of a niche and no obstruction. On the lesser curvature of the pars media of the stomach a sessile mass 1.7 by 1.6 cm. was noted. It was freely movable but no mucosa folds were demonstrated over it. Peristalsis was normal. Roentgenographically the mass appeared benign, but because of the patient's age, history of weight loss and mucosal disturbance it was decided to do an exploratory operation. A resection was done.

Pathological Report. Gross description: On the lesser curvature of the pars media there was



FIG. 3. Case II. Roentgenogram showing the pancreatic nodule.



FIG. 4. Case III. Roentgenogram showing the pancreatic nodule.

found a 1.5 by 1.5 cm. sessile mass with the mucosa over it intact but stretched and thinned. Microscopic description: The mass consisted of a collection of pancreatic glandular tissue extending down into the submucosa. Only a few small ducts were seen. No islands of Langerhans were seen. Microscopic diagnosis: Aberrant pancreatic nodule.

CASE III. This patient was a male, aged fifty-one, who had a one year history of gallbladder disease. For the past month he had had frequent attacks of gallbladder colic. Physical examination was negative except for diffuse tenderness in the right upper quadrant.

Roentgen examination revealed a 1 by 1.5 cm. opaque calculus in the gallbladder. In the stomach a soft pliable mass about 2 by 3 cm. was noted in the lower portion of the body on the anterior wall. The rugal folds were intact and thinned, but separated. Peristalsis was normal. At operation the surgeon decided to do a resection.

Pathological Report. Gross description: There was a 3 by 2.5 cm. size mass on the anterior wall of the pars media of the stomach and the mucosa over the mass was intact. Microscopic

description: Aberrant pancreatic glandular tissue was found.

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REFERENCES

1. BRANCH, C. D., and GROSS, R. E. Aberrant pancreatic tissue in gastro-intestinal tract. *Arch. Surg.*, 1935, *31*, 200-224.
2. BROWN, S., FLACHS, K., and WASSERMAN, P. Aberrant pancreatic tumor in duodenal wall. *Radiology*, 1944, *43*, 385-386.
3. KAUFMANN, E. *Pathology for Students and Practitioners*. Translated by S. P. Reimann. P. Blakiston's Son & Co., Philadelphia, 1929, Vol. 2, pp. 1021-1022.
4. FAUST, D. B., and MUDGETT, C. S. Aberrant pancreas, with review of literature and report of case. *Ann. Int. Med.*, 1940, *14*, 717-728.
5. GRANET, E. Aberrant pancreas simulating gastric neoplasm. *Med. Rec.*, 1940, *151*, 125-126.
6. KING, E. S. J., and MACCALLUM, P. Pancreatic tissue in wall of stomach. *Arch. Surg.*, 1934, *28*, 125-138.
7. VIGI, F., and GAMBERINI, M. Aberrant pancreatic tissue in diverticulum of stomach. *Riforma med.*, 1924, *11*, 1.

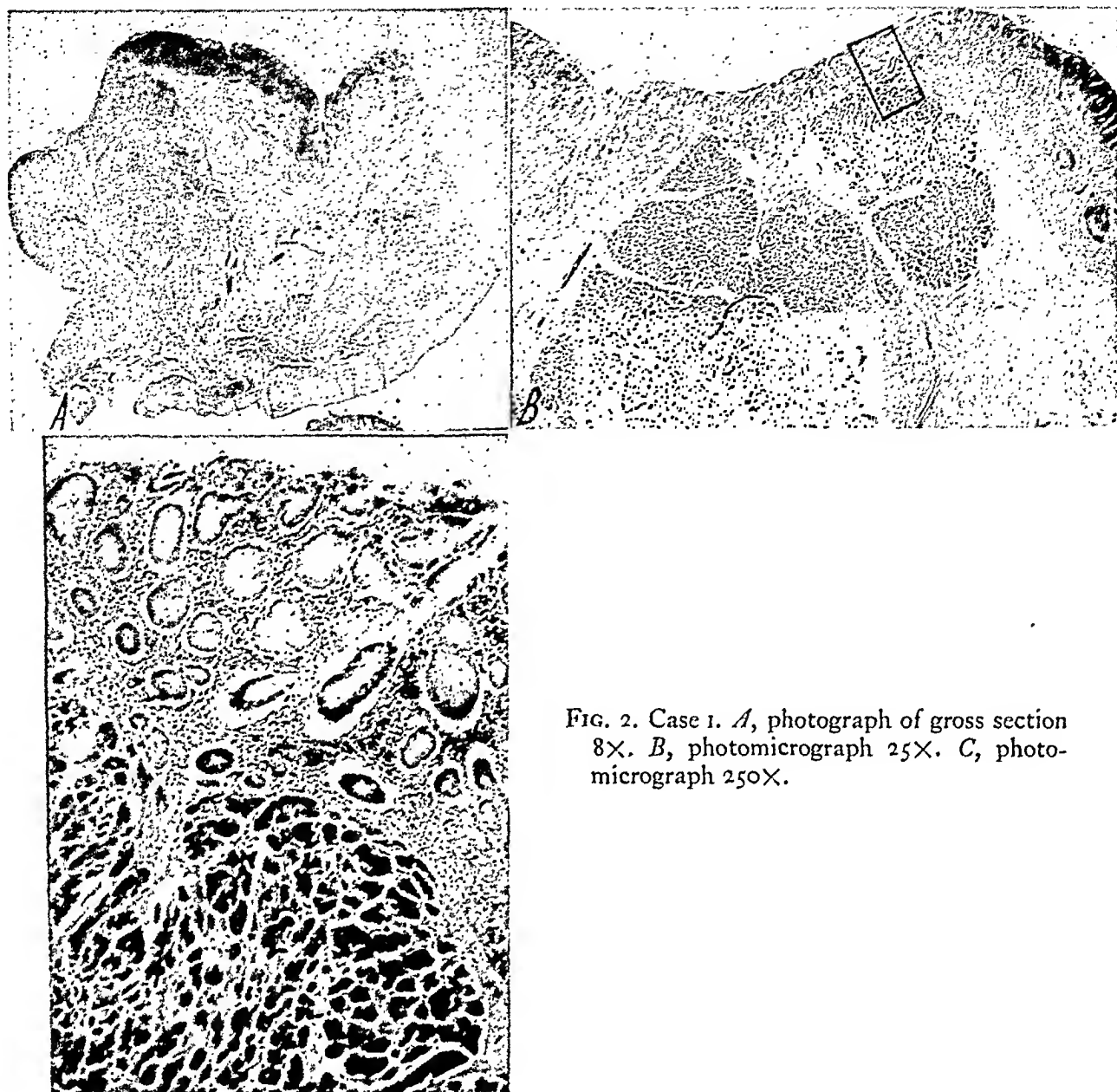


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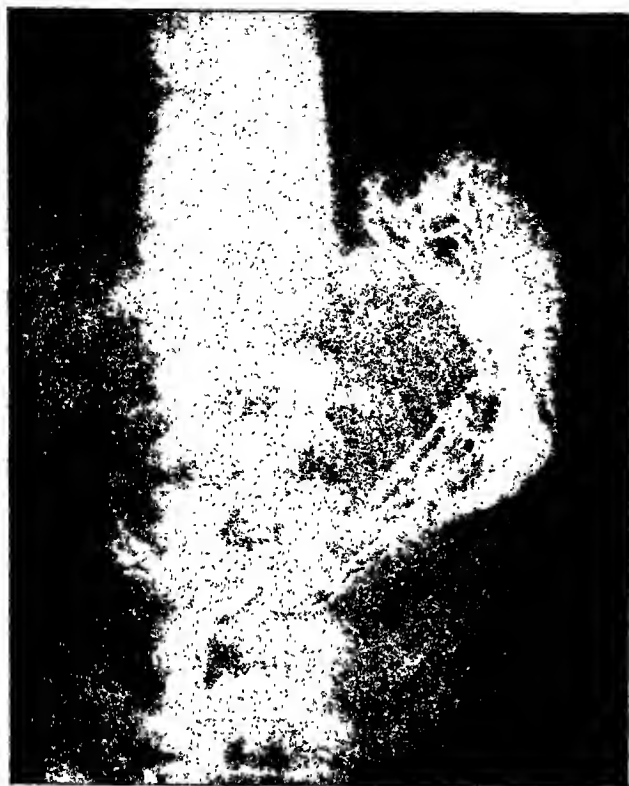


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2. BROWN, S., FLACHS, K., and WASSERMAN, P. Aberrant pancreatic tumor in duodenal wall. *Radiology*, 1944, *43*, 385-386.
3. KAUFMANN, E. *Pathology for Students and Practitioners*. Translated by S. P. Reimann. P. Blakiston's Son & Co., Philadelphia, 1929, Vol. 2, pp. 1021-1022.
4. FAUST, D. B., and MUDGETT, C. S. Aberrant pancreas, with review of literature and report of case. *Ann. Int. Med.*, 1940, *14*, 717-728.
5. GRANET, E. Aberrant pancreas simulating gastric neoplasm. *Med. Rec.*, 1940, *151*, 125-126.
6. KING, E. S. J., and MACCALLUM, P. Pancreatic tissue in wall of stomach. *Arch. Surg.*, 1934, *28*, 125-138.
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REPORT OF A CASE OF RUPTURED STOMACH IN AN INFANT THREE DAYS OLD*

By EUGENE P. PENDERGRASS, M.D., and ROBERT E. BOOTH, M.D.

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A RUPTURED viscus in an infant is a condition which is seldom encountered and from a review of the literature it is evident that rupture of the stomach in young infants is quite a rare condition. Also, in each case reported, a rupture of the stomach has been considered secondary to the presence of gastric ulcer. Postmortem statistics show that ulcers in children are absolutely and relatively of uncommon occurrence as compared with the incidence in adults. The cases are seldom recognized clinically early and usually are diagnosed only after perforation of the stomach or peritonitis has developed.

Theile in 1919 made a comprehensive review of the subject of ulcers of the stomach of children. He found reports of 248 cases of ulcers in childhood with very few in the neonatal period. He discovered 185 cases of ulcer of the duodenum in children were in boys and 98 were in girls. Sixty-one of the ulcers in his series were not located definitely or differentiated as to in which sex. Bowes was of the opinion that gastric ulcer in infancy predominated in the female.

Perforation of the stomach occurred in only 5 of Theile's cases of ulceration of the stomach and the age of onset of symptoms varied between twelve hours and eleven days in those cases in the neonatal period. The ulcers were described in some cases as having round and sharp cut edges and in others as having torn edges. They were single in all of the cases reported except two. In those cases in which histopathological examinations were made of the stomach at the site of perforation, the changes described were those of necrosis and hemorrhage into the tissue near the point of rupture. A cellular reaction similar to that found in peptic ulcer was not found

nor were the evidences of embolism or thrombosis found.

Hibbard reported an interesting case in a three months old female infant with a diphtheritic membrane in the throat. The infant had a perforating gastric ulcer with hemorrhage. Histopathologically the ulcer appeared to be an acute process due to disturbance of circulation of the stomach produced by hyaline thrombi with resultant necrotic mucous membrane which was digested away by gastric juice. There was no granulation tissue or chronic inflammation, and he believed that the ulcer may have started as a diphtheritic lesion of the gastric mucous membrane.

The etiology of such ulcers is quite obscure. Adler believed that it was difficult to explain the occurrence of ulcers in the first few days of life on any other basis than that during parturition a hemorrhage into the mucosa occurred with subsequent auto-digestion. An infectious origin in children seems quite possible, however. One author regarded the mechanism of their formation as a local disturbance in circulation which, from the action of the gastric juice, led to necrosis and ulceration. He mentioned as causes of this congestion, embolism, thrombosis, vascular disease, direct injury to the mucous membrane and nervous influences. Also, focal lesions of the hypothalamus and congenital defects in the structure of the stomach have been implicated.

Theile believed that in the adult one sees a primary type of ulcer, whereas in the child a secondary type of ulcer is found. The causes of the latter, Theile lists as melena neonatorum, marasmus (usually causing duodenal ulceration), infectious ulcers such as are seen in conjunction with syphilis or tuberculosis, burns, nephritis and uremia, congestive and catarrhal

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processes in the mucous membrane (follicular gastritis), or direct trauma. Of Theile's 248 cases, 64 were due to melena neonatorum, 60 to marasmus, 31 to burns, 21 to tuberculosis, 26 to other infections, and 2 to uremia.

Fenwick recognized five varieties of gastric ulcer: (1) hemorrhagic erosions as a result of congestion of vessels of the mucosa due to cardiac valvular disease, dilated heart, pulmonary disease, rarely cirrhosis of the liver, scurvy, and blood dyscrasias; (2) follicular gastritis, due to inflammation of solitary lymph glands with subsequent necrosis and ulceration; (3) tuberculous ulcers; (4) malignant ulcers; (5) true peptic ulcer, either acute or chronic and varying grossly from the adult type in not always being round and punched out.

Direct trauma to the mucous membrane of the stomach may be considered as a possible cause in some cases because a tube might be used for gavage or lavage. The use of a tube was noted in some reported cases before any abdominal distention appeared. However, it seems highly improbable that a normal mucous membrane could be damaged by a soft rubber catheter. Similarly, in another case, a tube was introduced into the stomach and the trauma in this case was thought *not* to have caused rupture of the stomach because signs of peritonitis developed before the tube was introduced.

CASE REPORT

A case of perforation of the stomach in an infant was observed in the Hospital of the University of Pennsylvania in August, 1941. The condition occurred in a three day old female infant seen in the hospital nursery following a precipitous delivery. The mother, a colored female, aged twenty-three, was a multipara with two previous normal full term deliveries, the last child having been delivered two years previously. Both of the children were living and well.

The mother's prenatal course was normal except for some pretibial edema in the latter months of her pregnancy. Her blood Wassermann reaction was negative as was a smear for

gonococci. The present pregnancy was at term, presenting left occiput transverse; and the following delivery was normal in all respects on August 21, 1941.

However, the infant was cyanotic at birth and received *intratracheal oxygen* for approximately five minutes. The child had attained forty-one weeks of maturity, there were no apparent malformations, and only a slight moulding of the head. The weight of the baby was 3,300 grams and the length 51 centimeters. The infant nursed quite well going to the breasts on August 22, 1941, and seemed to be perfectly normal postnatally. On the morning of the third day following delivery, however, the child was found to have a moderate abdominal distention and its temperature rose to 100° F. Peristalsis was present and active and meconium was passed by rectum. Nevertheless, the distention increased during the day and it appeared to embarrass respiration.

Roentgenoscopic and roentgenographic examinations in the horizontal and erect postures at that time revealed what was thought to be a perforated viscus since there was subdiaphragmatic air with a fluid level in the abdomen (Fig. 1 and 2). It should be recorded that in the horizontal posture the true nature of the abdominal distention could not be ascertained.

An emergency laparotomy was performed with a preoperative diagnosis of perforated viscus. A right rectus incision was made and a large amount of gas and bloody fluid were evacuated from the peritoneal cavity. There was no clue as to the location of the perforation of the hollow viscus so the intestinal tract, which came into view immediately, was examined first. There was no evidence of perforation of the small intestine but it was possible to find material coming down from the upper abdomen, an opening was found in the anterior surface of the stomach near the lesser curvature. This opening was about 1 cm. in length. There was very little induration about it and there appeared to be no obvious explanation for its presence. The gastric contents were aspirated from this neighborhood and the opening in the stomach was closed with two rows of continuous catgut sutures of No. 5 chromic catgut. The peritoneal cavity appeared then to be as clear in this area as in any other area, and it was decided not to drain. The small intestine was replaced in the peritoneal cavity and the wound was closed with steel wire in one layer.



FIG. 1. Pneumoperitoneum with fluid level due to a ruptured viscus.

The patient returned to the ward in fair condition.

The postoperative course of the infant was gradually retrogressive. The child took no nourishment by mouth and its weight decreased to 3,100 grams. Two days later the infant died.

At autopsy, the most significant findings were in the gastrointestinal tract. The intestines were adherent to each other, to the peritoneal surfaces and to other organs. They were covered with a fresh brownish exudate, most marked in the right upper quadrant. The small bowel was markedly distended with gas.

The stomach showed an intact suture line on the lesser curvature. On the greater curvature, plastered against the spleen, was a defect in the gastric wall about 0.5 by 0.5 cm. There was a small amount of submucosal hemorrhage about the perforation so that it appeared to have had an antemortem occurrence. The remainder of the gastrointestinal tract was normal except for two raised white areas on the serosal surface of the first portion of the ileum.

Microscopic section of the stomach through the area of the operative incision showed the wall to be pulled together by sutures, but there

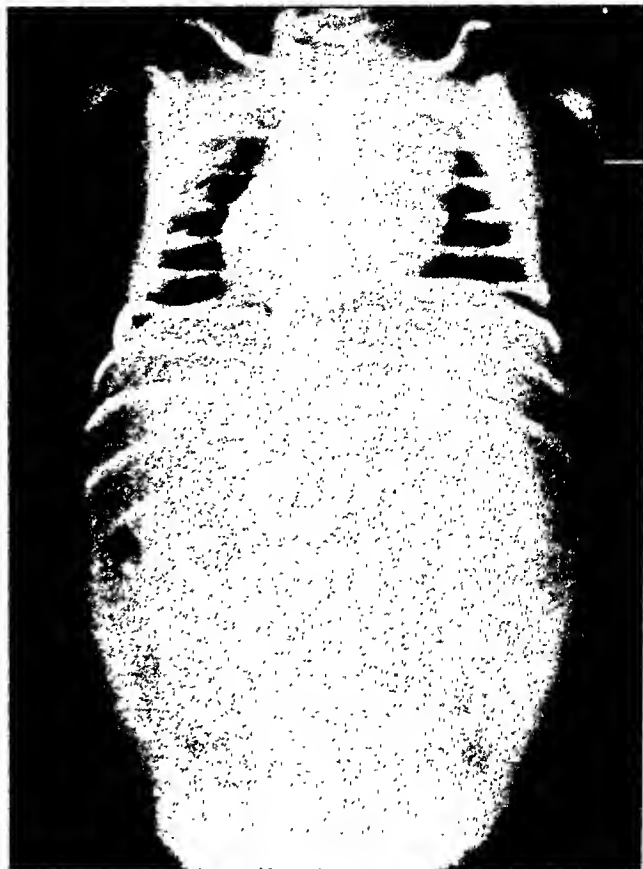


FIG. 2. Same patient as Figure 1. The examination was done in the horizontal posture. One does not obtain any idea of the real cause of the distention. The illustrations (Fig. 1 and 2) indicate the importance of the use of the horizontal beam in recording roentgen manifestations in distention of the abdomen.

was no real union of the edges, which were covered with necrotic exudate containing bacterial colonies. The submucosa was edematous and congested, but no intrinsic disease was apparent. The serosa was covered with a fibropurulent exudate. The section from the edge of the posterior perforation showed no further lesion.

Therefore, in summary, this infant had two perforations of the stomach soon after birth and died as a result of a fibropurulent peritonitis on the fifth postnatal day. One perforation was repaired surgically but another on the posterior wall of the stomach was not found until autopsy. The appearance at autopsy suggested that this latter perforation was present at the time of operation and was overlooked due to its position and the fact that when one perforation was found and closed, an in-

adequate search was made for another perforation. No definite etiological factor was demonstrated, and there seemed to be no intrinsic disease of the stomach. Perhaps a possibility is that ruptures were caused by the pressure of the oxygen used intratracheally at the time of delivery. Nevertheless, even if the soft rubber catheter which was used for the intratracheal introduction of oxygen (and which seemed actually to have been in the trachea because of the response of the baby) had passed into the stomach, it seems somewhat improbable that the normal mucosa would be perforated in two places. In the light of the well known occurrence of so-called spontaneous rupture of the intestine in the newborn infant, which is probably due to obstruction and trauma during birth a similar mechanism perhaps should be considered here. No such case has been reported, however.

Nevertheless, the significant fact remains that the diagnosis of a ruptured viscus should not be overlooked in an infant merely because of the patient's age. Likewise, in making a roentgen examination of an infant, one should not rely entirely on an examination in the horizontal posture if a vertical beam of roentgen rays is being employed. In this instance, such an examination, which is conventional, would not have revealed the true nature of the condition (Fig. 2). It is recommended, therefore, that at least one exposure be made in the erect posture (Fig. 1).

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REFERENCES

1. ADLER, H. Gastric ulcer in childhood. *Am. J. M. Sc.*, 1907, 133, 135.
2. ADRIANCE, V. Duodenal ulcer in an infant of ten months. *Arch. Pediat.*, 1901, 18, 277-279.
3. BARBER, C. F. Case of multiple ulcers in a child; sudden death. *Brooklyn Med. J.*, 1902, 16, 519.

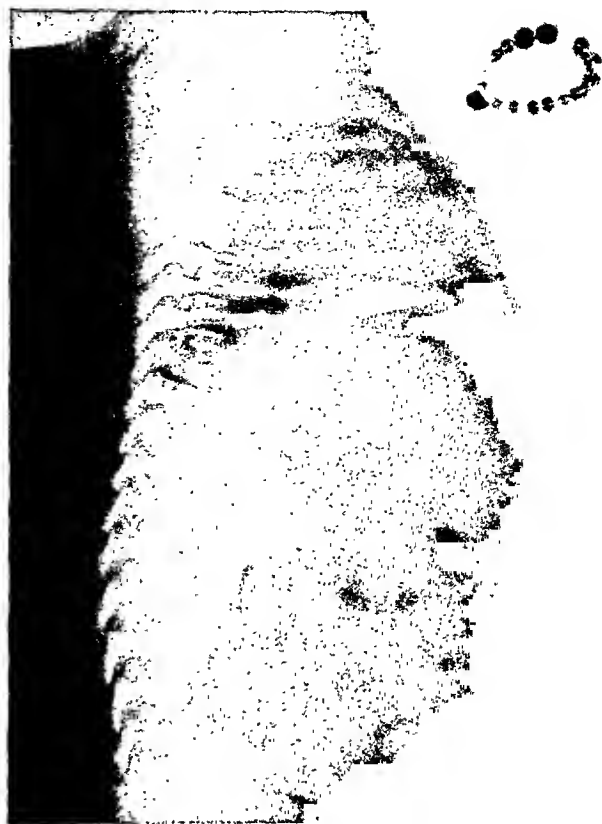


FIG. 3. Lateral view showing the free air in the peritoneal cavity and the distention of the small intestine.

4. BORLAND, H. H. Infantile duodenal ulcer. *Lancet*, 1903, 2, 1084-1086.
5. BOWES, L. N. Gastric ulcer in childhood, *Am. J. Obst.*, 1910, 61, 534.
6. FENWICK, W. S. Disorders of Digestion in Infancy and Childhood. London, 1897.
7. HIBBARD, C. M. Case of gastric ulcer in child four months old. *Boston. M. & S. J.*, 1897, 137, 177.
8. HOLT, L. E., JR., and McINTOSH, R. Holt's Diseases of Infancy and Childhood. Eleventh edition. D. Appleton-Century Co., New York, 1933.
9. LINCOLN, J. R. Gastric ulcer in the newborn. *Boston M. & S. J.*, 1897, 137, 178.
10. SHANNON, R. M. Case of ulcer of the stomach in an infant. *Ohio Med. J.*, 1909, 5, 216.
11. THEILE, P. Gastric and duodenal ulcers in children. *Deutsche Ztschr. f. Chir.*, 1919, 150, 275.
12. THEILE, P. Über Geschwürsbildungen des Gastroduodenaltractus im Kindesalter. *Ergebn. d. inn. Med. u. Kinderh.*, 1919, 16, 302.



ROENTGEN DIAGNOSIS OF RETROPERITONEAL LIPOMA*

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LIFCMATCUS tumors are characteristic though not frequent growths of the retroperitoneal space. They may occur in early childhood but usually appear in the fifth to sixth decade and are more frequent in women than in men. They may originate on either side of the vertebral column, but more often above the level of the kidney. They grow very slowly and sometimes reach a huge size (63 pounds, Boyd), the yellow, soft, fluctuant mass of fat thus filling the abdominal cavity from pelvis to diaphragm. Smaller ones tend to be spherical, sometimes lobulated. Often there are fibrous septa. The surface of the tumor is covered by the peritoneum of the posterior abdominal wall. Usually there are no peritoneal adhesions.

Microscopic examination reveals the characteristic large cells of neoplastic fat tissue. Myxomatous and fibrous areas are not infrequent, and about one-third of recorded cases display sarcomatous structures. Pemberton and Whitlock observed recurrent growth in approximately one-fourth of operated cases. The presence of myomatous and cartilaginous areas and the tendency toward recurrence, whether the microscopical structure is benign or malignant, influenced some investigators to place these tumors closer to teratomas than to lipomas.

Clinical symptoms are indefinite. The slow growth of the tumor and the adaptability of the soft, fatty tissue to the contour of surrounding structures provoke no symptoms in the early stages. If the tumor achieves vast proportions, its weight may cause abdominal distress, a sense of fullness, and occasionally constipation and backache. A large abdominal mass, of course, is constantly palpable. There are no labora-

tory tests to suggest the presence or absence of lipoma.

According to available information, accurate roentgenological diagnosis of retroperitoneal lipoma is unreported. These neoplasms have often been mistaken for kidney tumors or, if soft enough to fluctuate, for ovarian cysts. It seems to me, however, that several peculiarities should make the diagnosis possible. The following characteristics are specific to the extent that they may be regarded as basic considerations for diagnostic studies:

1. Displacement of the kidney without gross impairment of its shape and function.
2. Displacement of the abdominal viscera, but no evidence of organic lesions of the intestinal wall.
3. Expansive, not infiltrative, tumor growth.
4. Palpable, soft, sometimes fluctuating tumor. As a rule, no local tenderness.
5. Negative digital pelvic findings.
6. In contrast to the size of the tumor, mostly no signs of malignancy.
7. In contrast to the marked displacement of parts of the intestinal tract, no evidence of soft tissue shadow of the huge tumor, which could explain such displacement.
8. Occasional increased radiolucency of areas previously occupied by intestinal loops.

Due to the low atomic number of the constituents of fat, its absorption coefficient is lower than that of the surrounding structures. If we consider this value of water as 1.00, the corresponding value of fat is experimentally estimated to be approximately 0.486. The larger the tumor, the greater the contrast. Areas occupied by the tumor may even appear translucent. Dis-

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placement of intestinal loops accentuates the effect. Even in cases where the tumor contains fibrous, myxomatous, or myomatous tissue in addition to fat and there is no real radiolucent area, one still remarks the absence of such a soft tissue shadow as would be expected from the large palpable tumor, were it a cyst, hypernephroma, gravid uterus, or the like.

Laurell expressed the belief that fat-containing tumors of the abdominal cavity might be demonstrated. In one of his cases (a large retroperitoneal liposarcoma), however, the roentgen shadow of the tumor, instead of being less dense, was denser than the shadow of the adjacent structures, indicating that the fat content of this particular tumor was exceptionally low. (See also cases of Regan, Sanes and MacCallum.) Approximately 46 per cent of retroperitoneal lipomas are formed by pure fat tissue. Fifty-four per cent are myxolipomas and fibrolipomas. Thus, about one-half the total number possess the physical characteristics necessary to produce specific roentgen signs.

However, the only roentgenologic descriptions I have found of fat-containing tumors concerned dermoids. Such a case is illustrated in Figure 1.

CASE REPORTS

CASE I (A88453). A housewife, aged fifty, was admitted on April 5, 1939, complaining of being "chronically nervous." She had suffered from epigastric distress for the past fifteen years, loss of weight, and constipation. Physical examination revealed abdominal hyperesthesia with tenderness at the epigastrium.

At that time, roentgenograms of the gallbladder and upper gastrointestinal tract showed no evidence of retroperitoneal growth.

A new admission three years later (1942) disclosed a history of abdominal enlargement for one year, as well as additional loss of weight. Physical examination revealed a soft, slightly tender abdomen. A large, irregular, movable mass was palpated in the right mid-abdomen, extending from liver to pelvis. The outlines of the tumor were blunt and soft. Roentgenograms taken at that time are seen in Figures 2 and 3.



FIG. 1 (2383—1945). R. R., female, aged twenty-six, with large, round, palpable tumor in lower mid-abdomen. Roentgenograms reveal semicircular shadow of fibrous capsule of tumor. Tumor does not cast a shadow, but is somewhat translucent. Arrows indicate fibrous capsule and teeth. Roentgen diagnosis of dermoid cyst was proved at operation. Removed cyst contained large amount of fatty material, hair, teeth, bone, and cartilage.

On June 16, 1942, Dr. L. R. Chandler removed a large retroperitoneal fatty tumor extending from the under surface of the liver to the pelvis.

Pathological Report (Dr. D. A. Wood). The gross specimen consisted of a lipomatous tumor, ovoid and lobulated, measuring 30 by 25 by 8 cm. and two smaller similar yellow ovoids weighing 160 and 8 gm. Their surfaces were covered by a thin, transparent, smooth membrane. Total weight of the specimens was 2,800 gm.

Histopathological Examination. Part of the tumor consisted of adult, adipose connective tissue cells with only occasional intervening capillaries. In some areas, small, fetal fatty cells with foamy to granular cytoplasm were present.

Diagnosis. Retroperitoneal lipoma.

Patient made a rapid recovery and had no complaints until her third admission on February 24, 1944. At this time, a soft, cystic, palpable mass 6 inches in diameter was again

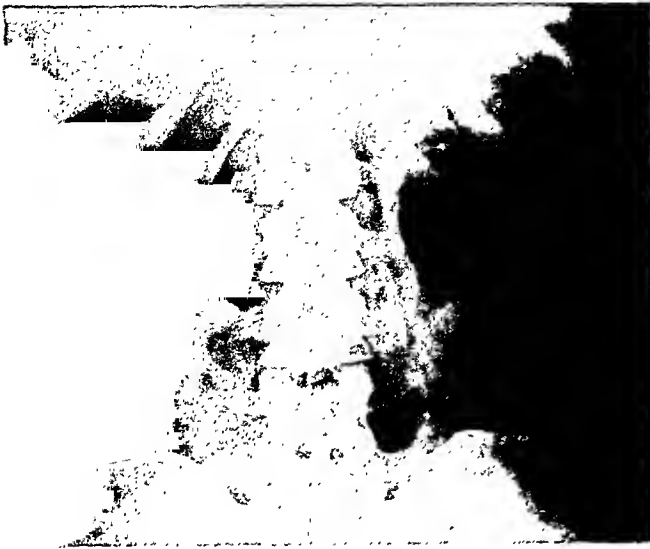


FIG. 2. Case 1. Excretory urogram (1942). Right kidney displaced downward to iliac crest and rotated to right. Dye excretion normal on both sides. Note large translucent area between liver, lumbar spine displaced kidney.



FIG. 3. Case 1. Excretory urogram (1942). Trans-lucency involves upper portion of right psoas shadow and transverse processes of the second and third lumbar vertebrae. Large translucent area corresponds to palpable mass in right abdomen.

felt above and about the area of the right kidney. It extended from the costal margin to

the umbilicus and to mid-abdomen. There had been right flank pain for five months and nocturia for the past two years. The diaphragm was elevated on the right. The abdomen was rounded and tender along the right side. The red blood cell count was 4,140,000; hemoglobin 76 per cent (Sahli). Figure 4 shows the roentgen findings.



FIG. 4. Case 1. Excretory urogram (1944). Right kidney displaced downward somewhat more than on first examination. No other changes. Large, translucent area above kidney remains unaltered. Note caudad displacement of gas-distended hepatic flexure, similar to that seen previously.

Exploration revealed most of the recurrent growth located retroperitoneally near the mid-line and in the transverse mesocolon and gastrocolic omentum, and between the hepatic flexure and the pancreas. There were at least twelve tumors varying from 1 cm. to 6 cm. in diameter. It was deemed impossible to remove all of them; however, one large tumor mass was extirpated by incising the peritoneum at the base of the transverse mesocolon.

Pathological Report (Dr. D. H. Carnes). The gross specimen consisted of a flattened, ovoid, fatty mass 8 cm. in greatest diameter, weighing 120 gm. The mass floated in formalin and ap-

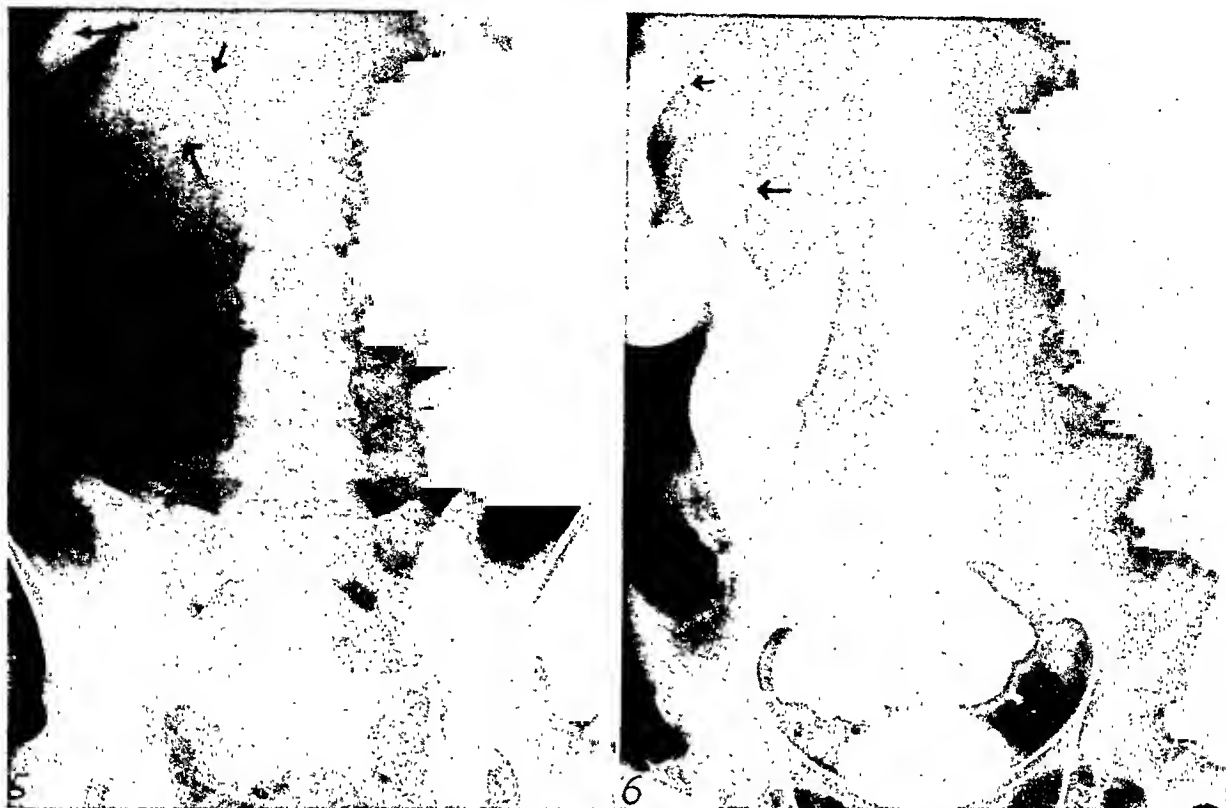


FIG. 5 and 6. Case II. Note remarkable translucency of almost entire left and of middle right abdominal fields. Right kidney displaced cranially, left caudad. It is rotated outward (arrows, Fig. 5). Function good in both kidneys. Upper calyx of left kidney somewhat elongated. Entire intestinal canal displaced toward right. Stomach and duodenum in right upper abdominal quadrant (arrows, Fig. 6). Colon pushed toward right. Gallbladder, containing numerous stones, pushed upward (arrow, Fig. 5).

peared to be composed of uniformly lobulated fat tissue.

Histopathological Examination. The tissue was composed of large, fully developed fat cells forming ordinary looking adipose tissue.

Diagnosis. Lipoma.

CASE II (No. 32507/41). A white woman, aged forty-two, complained of distention and a sensation of abdominal fullness and heaviness of eight to ten months' duration. Intensity of symptoms and size of the abdomen have increased during the past months. Previous health was excellent. There was no weight loss.

Physical examination showed a well developed, well nourished woman in apparently robust health. In the recumbent position, the abdomen was moderately distended above the level of the thorax and slightly asymmetrical, the left side being fuller than the right. Abdominal resistance was increased, and a soft mass with indefinite outlines was palpated to the left of the navel. No tenderness was elicited, but the patient complained of some vague distress on

deep palpation. Peristaltic sounds were absent except in the right upper abdominal quadrant. Pelvic examination was negative. Roentgen findings were summarized as follows:

Large, abdominal tumor displacing the gastrointestinal tract toward the right side of the abdomen and the left kidney downward and outward. Remarkable translucency of the areas occupied by the tumor indicates lipomatous structure. Displacement of the left kidney points to retroperitoneal origin. Lack of organic involvement of the wall of the gastrointestinal tract is significant of the expansive and non-infiltrative character of the growth (Fig. 5 and 6).

Roentgen Diagnosis. Large retroperitoneal lipoma. Cholelithiasis.

Five days after roentgen examination, the tumor and gallbladder were successfully removed. Laparotomy revealed a very unusual condition. The entire abdomen was filled by an enormous, yellowish-orange, smooth, spherical mass having the appearance of fat tissue. The outer surface was smooth and no adhesions were



FIG. 7. Case II. Gross specimen consisting of spherical, soft, yellowish-orange tumor measuring 20 to 28 by 16 to 18 cm. and weighing 12.5 kg. External surface smooth and shiny, consistency soft, similar to that of fat. Cut sections showed uniform, yellowish fat lobules with few fibrous septa and blood vessels.

present except around the left kidney. The tumor was connected with the left retroperitoneal space, involving the area from the spleen downward to the region of the iliac crest. Opera-

tive removal presented no great technical difficulties and the patient recovered uneventfully. Figure 7 is a photograph of the tumor.

Microscopically, the tumor consisted of uniform, large fat cells with a small amount of connective tissue and few blood vessels of various sizes between the lobuli. No structures of malignant growth were evident.

Pathological Diagnosis. Large retroperitoneal lipoma, benign.

CASE III (San Francisco Hospital, 6-14-45, No. 98833). Roentgenograms of this case were submitted to me for consultation. Clinical data of this patient, male, aged fifty-one, were not available. Roentgen examination revealed a marked upward displacement of the stomach and first portion of the duodenum. The second and third portions of the duodenum were compressed and horseshoe-shaped. The small intestinal loops were displaced toward the left (Fig. 8). The entire colon, including rectum and sigmoid, was pushed toward the right (Fig. 9). No signs of circumscribed infiltrative lesions were evident in the gastrointestinal tract. The left kidney was displaced upward, and the middle portion of the right ureter was deviated toward the right and anteriorly. The urinary bladder was compressed on the right side. Function was good in both kidneys. Both psoas



FIG. 8. Case III.



FIG. 9. Case III.

and kidney shadows were distinctly visualized (Fig. 10).

Displacement of the kidney, ureter, and duodenum indicated the retroperitoneal origin of the tumor. Displacement of the stomach and colon, and compression of the urinary bladder demonstrated the extraordinary dimensions of the tumor which occupied the retroperitoneal space bilaterally from the diaphragm to the floor of the pelvis. Despite the enormous dimensions of the tumor, no soft tissue shadow was present, indicating considerable fat content of the tumor. The fact that radiolucency was not marked despite the size of the growth suggested that the tumor might contain some collagenous tissue in addition to fat.

Roentgen Diagnosis. Large retroperitoneal lipomatous tumor.

At operation, a tremendous retroperitoneal fibro-myo-liposarcoma was removed.

Microscopical examination of the specimen revealed that most of the tumor consisted of pure fat tissue. The fat cells were large, as in lipoma (Fig. 11). The intercellular septa were very delicate, but blood vessels appeared more numerous than usual. In other parts of the tumor, fibrous and myxomatous structures were present containing cells with huge, dark, irregularly outlined nuclei (Fig. 12). The protoplasm of these cells was translucent, revealing faint eosinophilic precipitates and large vacuoli, the contents of which were not apparent on microscopical examination. These probably consisted of fat. In these parts of the tumor, the intercellular spaces were filled with faintly eosinophilic

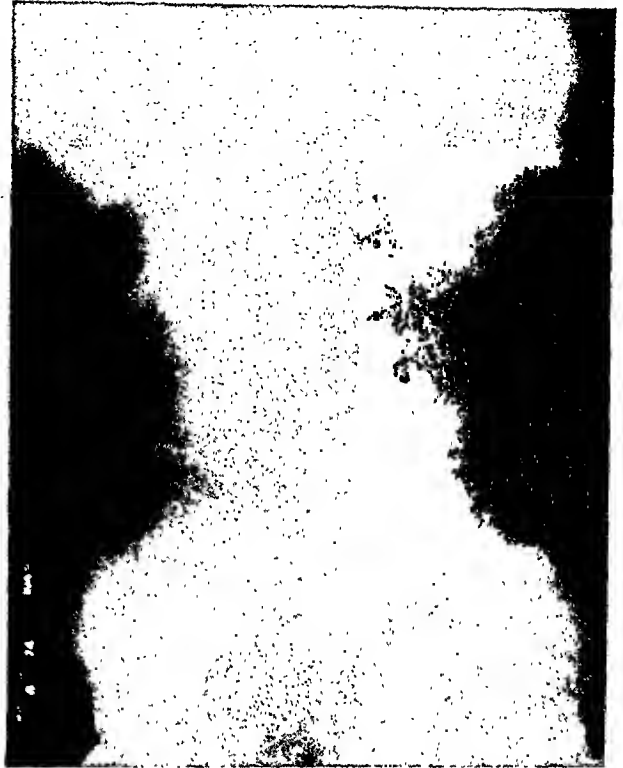


FIG. 10. Case III.

myxomatous material and delicate small bundles of connective fibers. Structures resembling smooth muscle were also observed.

Pathological Diagnosis (Dr. J. L. Carr). Large retroperitoneal fibro-myo-liposarcoma.

SUMMARY AND CONCLUSIONS

Roentgen signs of three verified cases of large retroperitoneal lipomatous tumors are

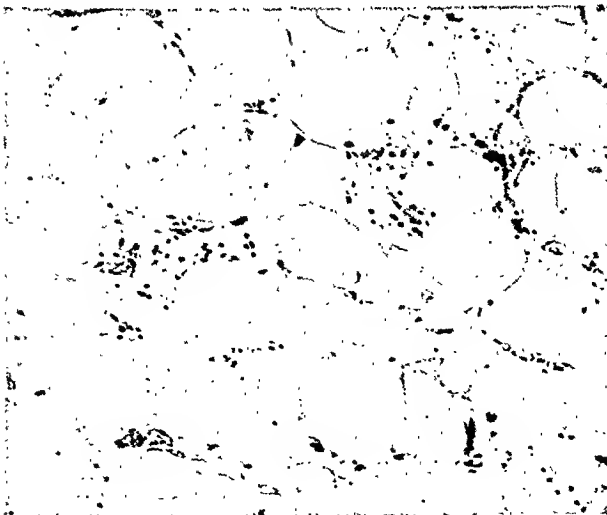


FIG. 11. Case III. Photomicrograph ($\times 300$) of lipomatous area of tumor. Hematoxylin-eosin.

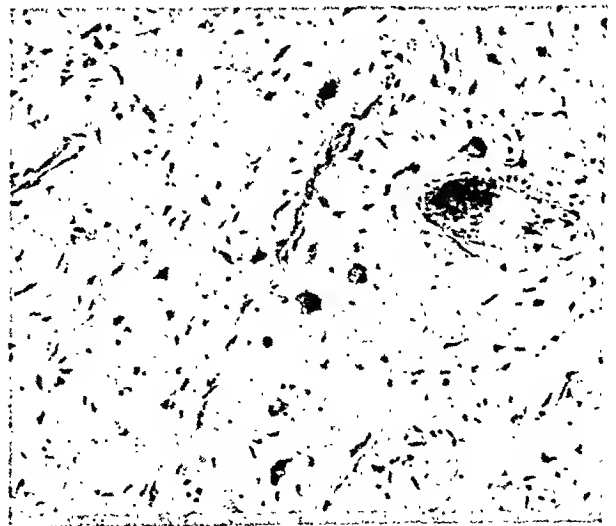


FIG. 12. Case III. Photomicrograph ($\times 300$) of sarcomatous area of tumor. Hematoxylin-eosin.

described. In two, accurate preoperative diagnoses were made.

The roentgen appearance was characterized in all cases by radiolucency of the areas involved and by displacement of retroperitoneal and intra-abdominal structures. Maximum radiolucency in two cases was localized cranial and in one caudad to the displaced but functioning kidney. No signs of circumscribed organic lesions of the gastrointestinal tract were present. In the third case, a fibro-myo-liposarcoma, translucency was less marked. A soft tissue shadow of the tumor was absent despite its huge dimensions, reaching from the diaphragm to the floor of the pelvis and displacing the entire gastrointestinal tract.

Approximately 50 per cent of retroperitoneal lipomas are composed of pure fat tissue. Roentgenographic demonstration of them is due to the greater radiolucency of fat and displacement of retroperitoneal and intra-abdominal structures. The translucency above or about the displaced kidney is most easily recognized after the tumor has reached considerable size. At this period of development, the effects of shadow abstraction of the fat (and of displaced and therefore absent intestinal loops) are greater than the effects

of shadow summations in the remainder of the abdomen.

The remaining 50 per cent of retroperitoneal lipomas contain varying amounts of myxomatous and fibrous tissue, by reason of which no marked radiolucency is present in areas occupied by such tumors. However, if they attain large size, displacing surrounding abdominal structures, and do not cast adequate soft tissue shadows, it is reasonable to believe they are of lipomatous origin.

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REFERENCES

1. BOYD, W. *Surgical Pathology*. Fifth edition. W. B. Saunders Co., Philadelphia, 1942.
2. LAURELL, H. Zur Röntgendiagnose klinisch schwer feststellbarer fettführender Tumoren, insbesondere Lipome. *Upsala Läkaref. Förh.*, 1928, 34, 693-708.
3. PEMBERTON, J. DEJ., and WHITLOCK, M. E. Large retroperitoneal lipoma; report of case. *Surg. Clin. North America*, 1934, 14, 601-606.
4. REGAN, J. S., SANES, S., and MACCALLUM, J. D. So-called retroperitoneal lipoma. *Ann. Surg.*, 1943, 117, 110-117.
5. TEMPLETON, F. E. Roentgen diagnosis of lipomata. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1937, 37, 210-216.



ANKYLOSING SPONDYLITIS

REPORT OF OCCURRENCE IN TWO BROTHERS*

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THE cause of ankylosing spondylitis is not known. Heredity has not been one of the factors seriously considered either for this disease or rheumatoid arthritis. It seems desirable, therefore, to record the occurrence of ankylosing spondylitis in two brothers and to review briefly the literature on the subject.

Ankylosing spondylitis is a particular form of rheumatoid arthritis. The age of onset and the debilitating effects upon the general health are the same for both diseases. The pathological changes in the sacroiliac joints and the apophyseal joints of the spine as described by Güntz³ are identical with those which are seen in rheumatoid arthritis. They consist of proliferation of connective tissue over the joint cartilage and in the subchondral spaces leading first to obliteration of the joint space and then gradually to complete absorption of the joint cartilage. There is first fibrous union between the two moving elements of the joint which eventually leads to complete bony ankylosis and such rearrangement of bone trabeculae that not the slightest evidence of the former presence of a joint remains. The fundamental lesion is the ankylosis but this process is accompanied and followed by calcification of the intervertebral and intraspinal ligaments until the spine is transformed into a solid immovable bony column. When the dorsal spine is involved, the ribs become ankylosed to the vertebral bodies with resulting fixation of the bony thorax.

The sex incidence is at marked variance from that of rheumatoid arthritis. Ankylosing spondylitis is predominantly a disease of men, less than 10 per cent of the cases being found in women. The onset occurs most frequently in young adult-

hood. Ehrlich,² in a survey of 753 cases, noted age of onset from sixteen to fifty but the median age was thirty-one. The disease begins as backache, lumbago or sciatica. The onset may follow an injury or a sprain, and the symptoms are intermittent at first but soon they become constant. Soreness and stiffness of the back continue and progress until the back becomes completely and permanently stiff in one to several years. During the active phase of the disease the patient suffers constitutional ill health with loss of weight, fatigability, irritability and general loss of efficiency. Finally a quiescent stage is reached when the general health returns to normal and the patient becomes as well as he was before his illness except for the mechanical disadvantages of a completely stiff back.

Physical examination shows evidence of loss of weight, stiffness of the spine, flattening of the normal lumbar lordosis, loss of chest expansion, mild kyphosis and a characteristic waddling gait. Not infrequently there is an associated arthritis of the hips with limitation of motion or even complete fixation of these joints. During the active phase of the disease there is anemia and a rapid sedimentation rate.

Early in the disease, roentgenological changes are slight and are limited to osteitis of the sacroiliac joints but these finally become completely fused. Oppenheimer⁷ believes the earliest changes are manifest in the apophyseal joints. With special technique employing oblique projections, haziness, narrowing, and finally complete fusion can be observed. Late in the disease, after permanent stiffness of the spine is apparent, calcification occurs in the anterior, lateral and posterior ligaments of the vertebrae as well as the interspinous

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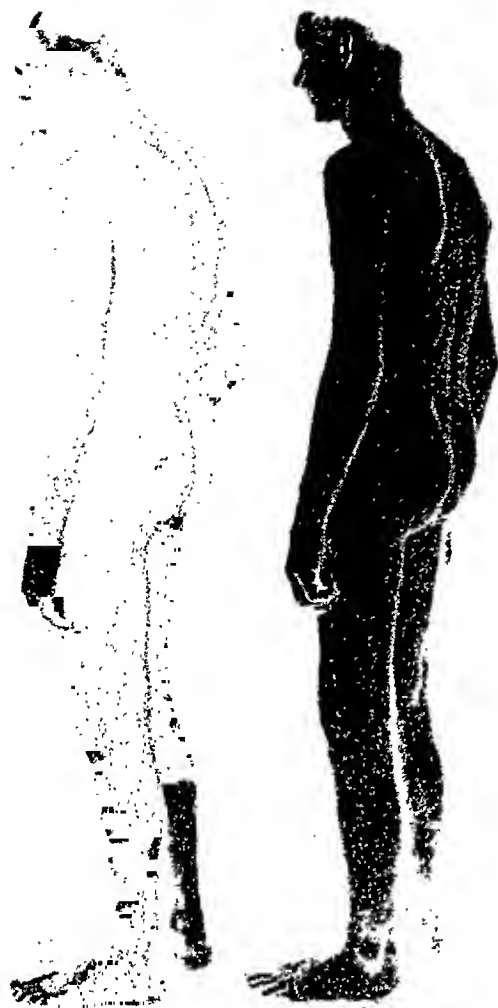


FIG. 1. Photographs of two brothers with ankylosing spondylitis demonstrating posture with moderate dorsal kyphosis, forward inclination of the cervical spine and hyperextension of the head. Case I on the left, Case II on the right.

ligaments producing the typical bamboo spine. The intervertebral discs maintain their normal size and shape throughout the disease.

CASE HISTORIES

The family history of our patients is as follows: the father died at the age of fifty-five of pneumonia, and the mother died at eighty of old age. Of the 8 children, 3 died in infancy and the oldest brother died at fifty-five of unknown cause. Two sisters, aged fifty-four and forty-four are living and well. There was no history of arthritis, rheumatism or backache in the family except as described below.

The father was very deaf, and the mother had normal hearing. The oldest brother, both

patients and the two sisters, all of the children now surviving, are hard of hearing. Paul wears a hearing aid.

The brothers, subject of this report, were forced to quit school and go to work at an early age and have done hard work all their lives. They are intelligent, alert and cooperative.

CASE I. Paul is now forty-nine years of age. His arthritis began without known predisposing events at the age of twenty-three years as pain and soreness of the right hip. After a period of several months the difficulty spread to the left hip. Pain was sufficient to produce limping, but it did not keep him from work. After two years, the pain spread to the lower back. He gradually became stooped with pain and suffered from cramps in his ribs. A full back cast was applied for six weeks. Three months after the first cast was removed, a second one was applied for another period of six weeks. The constant stabbing pain in the lower back which he had had for several years disappeared after treatment with casts. In 1925, about seven years after onset, the back was straightened by manipulation under ether anesthesia and another cast applied. He suffered severe pain in the back after this procedure for three days but it subsided subsequently. This cast, worn for four weeks, produced great improvement in his posture, an improvement he has maintained since that time. There has been no pain whatever for the last ten years and his health has been good.

Before onset of his illness this man weighed 175 pounds and was 6 feet 2 inches tall. He now weighs 155 pounds.

The most interesting features of the physical examination are shown in the photograph (Fig. 1). The posture is characteristic of the disease with moderate kyphosis of the dorsal spine, forward inclination of the cervical spine and hyperextension of the head. The spine is completely stiff throughout its entire length and consequently its shape is not changed at all when the patient stoops. He is able to bend over by hip motion alone. The lumbar spine is flattened obliterating the normal lordosis. Chest expansion is nil. The range of head motion is not restricted. The gait is awkward, a sort of waddle, characteristic of this disease. All other joints are normal.

Röntgen Findings. Anteroposterior and lateral projections of the lumbosacral spine and pelvis and lateral projections of the cervical

and thoracic vertebrae showed a diffuse "washed-out" appearance of the vertebral bodies, the result of severe generalized bone atrophy. The anterior, posterior and lateral spinal ligaments were calcified, forming a definite bridging between the bodies of the cervical and lumbar vertebrae producing the so-called "bamboo spine." A moderate degree of cupping of the upper and lower end-plates of the vertebral bodies were present indicating expansion of the cartilaginous discs, the result of softening of the vertebral bodies due to demineralization. These changes were less pronounced in the thoracic region where a moderate degree of kyphosis existed. The majority of the small apophyseal joints were obliterated by healing changes in the form of bony ankylosis. Both sacroiliac joints showed a combination of sclerotic and atrophic changes with complete disappearance of any evidence of these joints ever having been present. An additional feature, not observed regularly in ankylosing spondylitis, was the presence of amorphous-like calcifications in several of the disc cartilages in the thoracic and lumbar regions. The hip joints were of normal appearance (Fig. 3A, 4A and 5).

Paul has always been able to work except for the periods of hospitalization as previously described. He is now employed as a machinist.

CASE II. Reuben is now forty-seven years of age. Arthritis began gradually at the age of twenty-nine years as pain in one hip spreading gradually to the other hip and involving the lower back about three years after onset. Nine years after onset, the patient was hospitalized and kept in bed in hyperextension for three months. This resulted in marked improvement in his posture. He wore a cast for nine months after discharge from the hospital and later a back brace. Before he became ill he weighed 200 pounds and was 6 feet 2 inches tall. Reuben was unemployed for several years only because of the depression, not because he was too sick to work. He is now quite well and works regularly as an elevator maintenance man.

Physical examination is about the same as that described for Paul except that the kyphosis is not so marked. The lack of mobility, the absence of chest expansion, and normal function of peripheral joints are the same in both cases (Fig. 1 and 2). He now weighs 155 pounds.

Roentgen Findings. Anteroposterior and lat-



FIG. 2. Photograph of Case 11 showing immobility of the lumbar and dorsal spine. Flexion occurs at the hips and in the cervical spine.

eral projections of the lumbar spine and pelvis presented changes in the sacroiliac joints similar to those found in Case 1. The calcification in the spinal ligaments was less marked and the apophyseal joints were only moderately involved (Fig. 3B and 4B). In the thoracic segment there was even less marked involvement of the apophyseal joints and ligamentous structures. The cervical spine was free of disease except for large osteophytes on the lower margin of the body of the fifth and upper margin of the body of the sixth vertebrae. Comparison of roentgenograms of the lumbar spine and pelvis made at a ten year interval disclosed only an increase in the amount and density of the calcification in the spinal ligaments and apophyseal joints.

LITERATURE

Weil and Allolio⁹ described ankylosing spondylitis in brothers, two cases quite similar to the ones described above. In Peter, the older brother, the disease began as mild backache at the age of twenty-two;

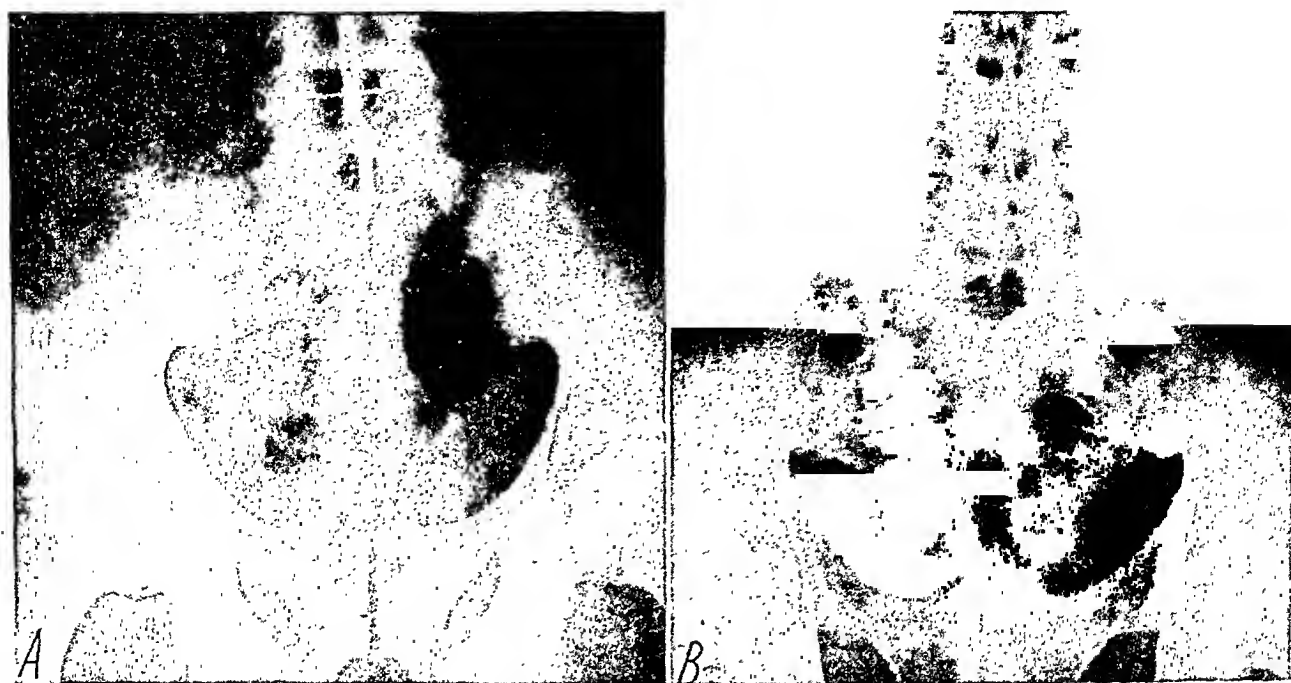


FIG. 3. *A*, Case I. Calcification and ossification of lumbar spinal ligaments, ankylosis of the apophyseal joints and obliterations of the sacroiliac joints. *B*, Case II. Lumbar spine and pelvis showing calcification of the apophyseal joints and spinal ligaments. The sacroiliac joints are completely ankylosed.

it became so severe in two years that the patient was practically bedridden. The following year he had sciatica in both legs and a constant pain extending farther up

his back. His gait became slow and staggering, and he developed a marked kyphosis. The pain became more severe and he gave up work entirely ten years after onset.



FIG. 4. *A*, Case I. Lateral projection of lumbar spine showing generalized atrophy, cupping of end-plates and calcification of the anterior ligament and second intervertebral disc. *B*, Case II. Lateral view of lower lumbar spine shows atrophy of the bodies, calcification of the anterior ligament, cupping of the end-plates and amorphous calcification in the disc cartilages.

Physical examination showed that the entire back was completely stiff up to the occiput. There was kyphosis of the thoracic region and flattening of the lumbar spine. The peripheral joints including hips and shoulders were completely normal. Roentgenological examination showed ossification of the interspinous ligaments with spurs in lumbar and lower dorsal region.

Mathias, the second brother, noted pain in the hips, sacrum and lower back coming on at the age of nineteen after he froze his feet. The pain was aggravated by standing. Since the age of twenty-six the pain has been constant; he had bowing of the back and pain and stiffness in the shoulders and the neck. Physical examination showed the spine to be completely stiff; there was kyphosis in the dorsal region and flattening of the lumbar spine. Roentgenological examination showed beginning calcification of the interspinous ligaments.

The authors believe these are typical cases of ankylosing spondylitis. A photograph of both brothers shows that both have the typical posture of the disease. In both instances the diseases began after exposure to cold and were thought to have been related to war service.

Reynolds⁸ reported another instance of the disease in brothers. Robert M., aged twenty-eight, a soldier in the Army, appeared normal except for some stiffness of the back. Roentgenograms showed changes about the sacroiliac joints with demineralization and beginning lipping in the dorso-lumbar spine which warranted a diagnosis of Marie-Strümpell type of spondylitis. His brother, James M., aged twenty-six, also had stiffness of the spine. Roentgenograms taken in 1943 showed obliteration of sacroiliac joint spaces with early lipping of the cervical and lower dorsal spine, changes of Marie-Strümpell spondylitis. Roentgenograms repeated a year later were essentially the same.

Ehrlich in an extensive review of 753 cases noted the occurrence once of ankylosing spondylitis in brothers. He gives no details except to state that one of the



FIG. 5. Case 1. Calcification in the anterior and posterior cervical spinal ligaments, atrophy and cupping of the bodies, and obliteration of the apophyseal joints.

brothers was discharged from the Army because of his condition.

Other instances have been found in the literature of multiple cases of ankylosing spondylitis in one family but the evidence is not convincing. Herrick and Tyson⁴ describe a thirty-two year old man with complete fusion of the sacroiliac joints and obliteration of the apophyseal joints of the thoracic and the lumbar spine. He had had symptoms for six years. His father was said to have had a poker spine. Blair¹ described a thirty-two year old man with demineralization of the spine, fusion of the sacroiliac joints, deformity of the pelvis and ankylosis of the spine. The diagnosis of ankylosing spondylitis would seem to be admissible here but it is in reasonable doubt concerning the twenty-three old brother. The latter patient had been disabled twice because of trauma to the back. Examination showed some stiffness of the spine, muscle spasm and difficulty with leg raising. "Roentgenograms showed irregularity of the sacroiliac joints with sclerosis of the adjacent bone and some decrease in definite markings of the lower lumbar postero-lateral

articulations." The diagnosis of ankylosing spondylitis would seem to be admissible in the first case but is doubtful in the second.

Weil and Allolio mentioned two further instances of familial involvement of the spine.

Marie and Astie⁶ described an old man and his sister with senile kyphosis. Magnus-Levy⁵ described another man with senile kyphosis who had two maternal aunts similarly affected.

DISCUSSION

We have here described the occurrence of ankylosing spondylitis in brothers. We have mentioned a second example of this phenomenon from personal communication and have described two additional instances from the literature which seem to be authentic. The cases of Herrick and Tyson involved a man and his father but the latter was not examined and so the diagnosis was not reliably established. The second brother of Blair's set is not acceptable. Senile kyphosis is quite a different disease from ankylosing spondylitis. It is a disease of old age; it is a result of severe demineralization and is characterized by marked dorsal kyphosis. The intervertebral discs become thin anteriorly so that fusion of vertebral bodies occurs in front. The apophyseal and sacroiliac joints are not involved.

The discovery of four instances of ankylosing spondylitis affecting brothers may be of no etiological significance. The disease is not rare so that multiple cases in the same sibship can be expected to occur occasionally by chance alone. The likelihood of such an occurrence resulting from chance alone cannot be computed from any statistics on the subject known to the authors. It may be relevant to note that although it is much more common than

ankylosing spondylitis, we know of only one instance of family involvement of rheumatoid arthritis, in which it affected sisters. Four instances of ankylosing spondylitis affecting brothers suggests a hereditary factor in this disease. We know of no other evidence supporting this proposition. Attempts have been made to explain the etiology of spondylitis on constitutional factors. The individuals herewith presented resembled each other closely in size, body build, pigmentation and facial features.

We are forced to conclude that the occurrence four times of ankylosing spondylitis in brothers does not lead to an explanation as to etiology because such a coincidence may have resulted from chance alone.

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REFERENCES

1. BLAIR, H. C. Spondylitis adolescens—Struempell-Marie disease; practical and theoretical considerations. *Surg., Gynec. & Obst.*, 1942, 74, 663-670.
2. EHRLICH. Die sogenannte Bechterew'sche Krankheit. Eine chronische zur Versteifung führende Erkrankung der Wirbelsäule. R. Hobbing, Berlin, 1930.
3. GÜNTZ, E. Beitrag zur pathologischen Anatomie der Spondylarthritis ankylopoetica. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1933, 47, 683-693.
4. HERRICK, W. W., and TYSON, T. L. Medical aspect of ankylosing spondylitis (Marie-Strümpell). *Ann. Int. Med.*, 1941, 15, 994-1001.
5. MAGNUS-LEVY, A. Über die chronische Steifigkeit der Wirbelsäule. *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1902, 9, 626.
6. MARIE, P., and ASTIE, C. Sur un cas de cyphose heredo-traumatique. *Presse méd.*, 1897, 2, 82.
7. OPPENHEIMER, A. Development, clinical manifestations, and treatment of rheumatoid arthritis of the apophyseal intervertebral joints. *Am. J. Roentgenol. & Rad. Therapy*, 1943, 49, 49-76.
8. REYNOLDS, L. Personal communication.
9. WEIL, A. J., and ALLOLIO, B. Spondylitis ankylopoetica (Bechterew) bei Brüdern. *Deutsche méd. Wchenschr.*, 1930, 56, 2038-2039.



OSSIFICATION OF THE CORACOCALVICULAR LIGAMENT FOLLOWING DISLOCATION OF THE ACROMIOCALVICULAR ARTICULATION

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CALCIFICATION or ossification of ligaments and tendons following trauma is recognized as a common condition and, in certain locations, is the usual sequela of hemorrhage into the injured structures. Codman² in his classic work on the shoulder described the type of calcification that is noted in the supraspinatus and other tendons following injury. Ossification frequently occurs in the medial collateral ligament of the knee and in hematomata beneath the quadriceps femoris, within the brachialis anticus, the rectus abdominalis and other muscles. Following injury to certain joints, notably the elbow, knee and ankle, small particles of osseous material appear in the peri-articular tissues weeks or months following injury.

Ossification of the coracoclaviclar ligament following partial or complete avulsion of this ligament incidental to dislocation of the acromioclaviclar articulation is a less well known condition, in spite of the fact that it is apparently a common sequela of a relatively common type of injury. In the series reported below, of 18 patients with dislocation of the acromioclaviclar articulation, 14 subsequently developed osseous deposits in the coracoclaviclar ligament.

ANATOMICAL FACTORS

The acromioclaviclar articulation is a diarthrodial joint between the center of the medial border of the acromial process of the scapula and the acromial end of the clavicle. The strength of the joint is largely in the ligaments about it—the articular capsule, the superior and inferior acromioclaviclar and coracoclaviclar ligaments. The articular capsule encases the joint, being attached about the articular margins. It is augmented above by a dense ligamentous band, the superior acromio-

claviclar ligament, which is continuous with fibers of the aponeuroses of the deltoid and trapezius muscles. Beneath the capsule is a similar band, the inferior acromioclaviclar ligament.

The coracoclaviclar ligament, while not in continuity with the capsule of the acromioclaviclar articulation, is of great importance in maintaining the normal relationship of the clavicle to the acromion process. This ligament consists of two fasciculi—the conoid and trapezoid ligaments (Fig. 1). The trapezoid fasciculus is a thin band of tough fibrous tissue which extends between the superior surface of the coracoid process and the oblique ridge on the inferior surface of the lateral third of the clavicle. The conoid fasciculus is a cone-shaped band, the apex of which is attached to the base of the coracoid process, the base to the conoid tubercle on the inferior surface of the clavicle. These two fasciculi join one another at an angle directed posteriorly.

The coracoclaviclar ligament thus anchors the clavicle securely to the coracoid process. Rotation of the scapula on the acromial end of the clavicle is limited by the two fasciculi—the trapezoid ligament limiting forward rotation and the conoid ligament limiting backward rotation.

Bosworth¹ states that the coracoclaviclar ligament may be likened to a stout cord by which the scapula and with it the whole upper extremity is suspended from the outer end of the clavicle.

Authorities differ regarding the function of the clavicle. The opinion which seems to be most commonly accepted is expressed by Mumford⁴ who states that the function of the clavicle, other than for attachment and origin of certain muscles, is purely one of supplying a strut or buttress to hold the tip of the shoulder out from the body. There is abundant evidence that defects in or absence of the clavicle do not produce disability. In mutational (cleidocranial) dysostosis, the clavicles are usually either absent or defective and shoulder function

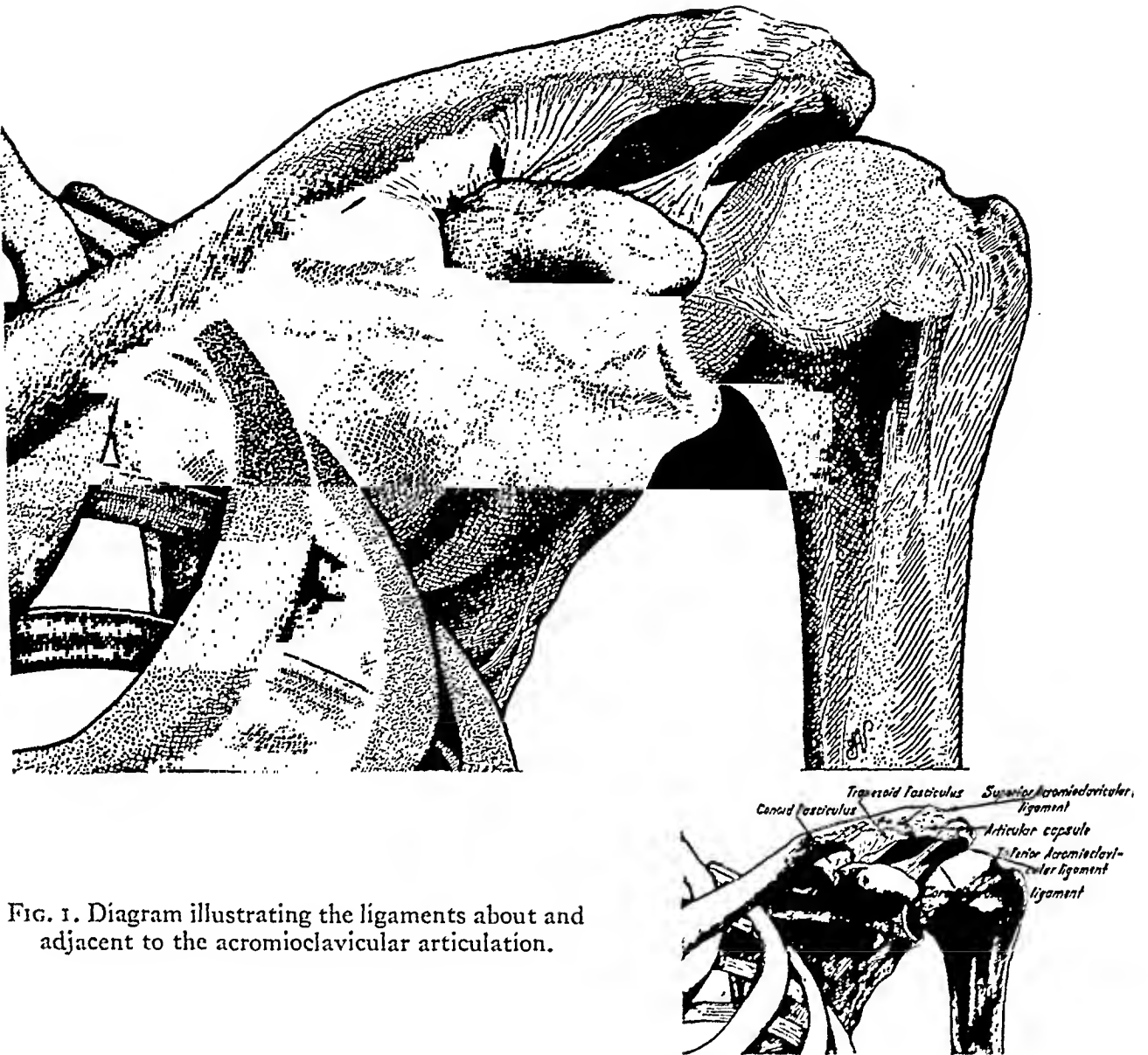


FIG. 1. Diagram illustrating the ligaments about and adjacent to the acromioclavicular articulation.

in such patients is rarely if ever abnormal. There are several cases on record where the entire clavicle was removed without subsequent disability. It seems probable in acromioclavicular separations that part of the disability which frequently follows such injuries comes from the fact that other structures of the shoulder have dropped away from the clavicle and the elevated acromial end of the clavicle pushes against the overlying soft tissues in certain motions. If several centimeters of the acromial end of the clavicle are resected, function is usually restored.

DISLOCATIONS OF THE ACROMIOCLAVICULAR ARTICULATION

Dislocations of this joint are described as incomplete or complete, the latter term

being applied when the coracoclavicular ligament is severed. In all dislocations, there is tearing of the articular capsule and usually of the superior or inferior acromioclavicular ligaments or both.

The commonest causes of either complete or incomplete dislocations are blows or falls directly upon the shoulder. Sudden force drives the scapula downward and backward. Downward excursion of the clavicle is limited by the rigid first rib below and by muscle pull from above with consequent tearing of the ligaments between the clavicle and scapula. Frequently, torn bits of capsule and ligaments become interposed between the clavicle and acromion, thus preventing complete reduction of the dislocation.

TABLE I
TABULATION OF CASES OF ACROMIOCLAVICULAR DISLOCATIONS

Case No.	Age	Date of Injury	Last Examination Before Ossification	First Examination After Ossification	Time Interval	Type of Injury	Clinical Notes	Result at Last Observation
I	26	6-18-43	6-22-43	7-10-43	More than 4; less than 22 days	Injured while wrestling	See case summary	Asymptomatic, 5 months
II	35	5-27-44	6-1-44	6-26-44	More than 5; less than 30 days	Fell in scuffle	See case summary	Improved, 2 months
III	37	6-3-43	6-3-43	1-21-44	Less than 8 months	Injured while wrestling	See case summary	Unimproved, 8 months
IV	30	3-31-44	3-31-44	5-30-44	Less than 60 days	Injured in train wreck	See case summary	Asymptomatic, 3 months
V	29	1-4-43	1-4-43	5-30-43	Less than 150 days	Thrown from jeep	See case summary	Improved, 11 months
VI	37	3-4-42	3-4-42	10-13-43	Less than 19 months	Fell against railroad track	See case summary	Unimproved, 2 years
VII	25	11-8-43	12-27-43	—	—	Fell, hitting side of building	See case summary	Asymptomatic, 2 months
VIII	37	7-7-42	12-19-42	—	—	Pulled shoulder in obstacle course	Resection of acromial end of clavicle; no ossification within 5 months	Improved, 6 months
IX	35	8-5-42	1-23-43	—	—	Fell while wrestling	Incomplete dislocation. No ossification within 6 months	Asymptomatic, 6 months
X	32	2-25-43	3-11-43	3-31-43	More than 14; less than 34 days	Thrown on shoulder; judo	Complete dislocation treated by operation (sutures of wire and fascia). Osseous deposits in ligament	Improved, 3 months
XI	50	1935	—	3-22-43	Less than 8 years	Horse fell on shoulder	Patient studied 8 years after injury; limitation of motion and history of intermittent pain; osseous deposits in ligament	No change
XII	33	6-3-43	6-3-43	8-7-43	Less than 65 days	Injured in jeep accident	Wide separation of joint treated conservatively; small amount of ossification in ligament	Improved, 5 months
XIII	38	7-8-43	7-22-43	9-1-43	More than 14; less than 54 days	Fell from truck, landing on shoulder	Moderate separation of joint; small amount of ossification	Improved, 4 months
XIV	27	12-30-43	—	4-8-44	Less than 100 days	Thrown from vehicle	Slight disability 4 months after injury; moderate separation of joint and partial ossification of ligament	Improved, 6 months
XV	45	1940	—	4-13-44	Less than 4 years	Auto accident	Slight disability with intermittent pain; moderate separation of joint and partial ossification of ligament	Unimproved, 4 years
XVI	23	6-26-44	8-26-44	—	—	Injured, playing football	Clinically incomplete separation treated by strapping; no ossification within 2 months	Asymptomatic, 2 months
XVII	29	8-16-43	—	8-23-44	Less than 1 year	Injured in fall, landing on shoulder	Clinically complete separation treated conservatively; 1 year later, small osseous masses in ligament	Improved, 1 year
XVIII	34	11-21-44	12-7-44	12-28-44	More than 16; less than 37 days	Caught between two trucks	Sustained bilateral dislocations of acromioclavicular joints; 2 months later no disability; moderate ossification of both coracoclavicular ligaments	Asymptomatic, 2 months

Speed⁶ states that while there may be associated damage to muscles and fascia, there is little blood extravasation present and injuries of blood vessels and nerves are almost unknown. Small fragments of

bone and cartilage may be detached from the clavicle or acromion and occasionally a fracture or dislocation may be present in the shoulder. He also states that after rupture of the fasciculi of the coracoclavicu-

lar ligament a process of calcification may infiltrate them and aid in stiffening the shoulder region. He believes that this ossification reaction undoubtedly comes from a tearing of the periosteum and the irritation from too early movement and use of the joint.

Liberson³ states that post-traumatic ossification of the ligaments, resulting either from injury or from improper attention to the acromioclavicular dislocation with injury to the ligaments, causes considerable hardship and disturbed function of the shoulder girdle.

Murray,⁵ on the other hand, reports several cases of acromioclavicular dislocation treated by insertion of Kirschner wires through the outer end of the clavicle and acromial process of the scapula in which there was development of extensive calcification of the coracoclavicular ligaments without subsequent deformity or disability.

If unsuccessfully reduced, the principal late effects of such dislocations are weakness and partial disability of the shoulder girdle, especially in such motions as lifting, pushing or picking up objects. The clavicle is virtually divorced from the remainder of the shoulder girdle and force which is usually transmitted to the trunk through the scapula and clavicle and their muscular and ligamentous attachments is thrown out of balance. This may amount to complete disability in a manual laborer

ROENTGEN FINDINGS

Anteroposterior roentgenograms of both shoulders taken in the upright position with a 20 pound weight in each hand will demonstrate widening of the injured joint and elevation of the acromial end of the clavicle. Small splinters of bone may be demonstrated if they are detached from the clavicle or acromion process. There is variability in the width of the joint space in different individuals; occasionally spaces as wide as 1 cm. may be present without dislocation. However, the disproportionate width of the injured joint and the abnor-

mally high position of the acromial end of the clavicle are the important diagnostic features.

Ossification of the coracoclavicular ligament has been observed as early as twenty-two days following injury. It usually appears as a group of amorphous, cloudy areas of light density below the outer third of the clavicle, frequently near the conoid tubercle and usually closer to the clavicle than to the coracoid process. These areas increase rapidly in size and density and within several weeks take on definite characteristics of bone, this being laid down in strands and spicules corresponding more or less to the lines of the fibrous strands of the conoid and trapezoid fasciculi. While the bone frequently becomes attached firmly to the clavicle above, it approaches, but rarely becomes continuous with the coracoid process below. The process of ossification appears to be progressive for a period of about eight to ten weeks and then shows no perceptible change on subsequent examinations.

Speed states that post-traumatic calcification is apt to be less marked if the shoulder is immobilized promptly. In the cases reported below, the production or absence of ossification appeared to have no relationship to motion as nearly all cases were immobilized shortly after injury.

If ossification has not appeared within six weeks following injury, it has not been noted in subsequent examinations.

It should be emphasized that while several authors have used the term "calcification" to refer to the changes present in the coracoclavicular ligament, the process actually is one of ossification with material easily recognizable as bone being laid down within the substance of the ligament.

REPORT OF CASES

CASE 1. A corporal, aged twenty-six, sustained a complete separation of the right acromioclavicular articulation while wrestling. A Velpeau bandage was applied within a few minutes following injury, but the deformity and pain persisted. Five weeks later, an open

reduction was performed and the clavicle and acromion process were approximated and held by fascial strips and a loop of wire was inserted through drill holes in each. Two months later the patient was sent to a rehabilitation center where he remained for six more weeks before being returned to full duty. Upon discharge, he had full range of motion and no pain or other complaints.

Roentgenograms of the right shoulder taken four days following injury (Fig. 2) shows the separation of the acromioclavicular articulation. Figure 3, a roentgenogram taken twenty-two

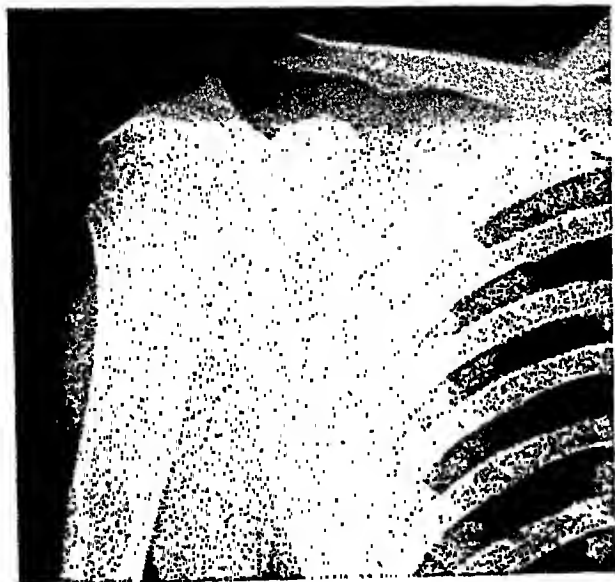


FIG. 2. Case 1. Four days following injury.

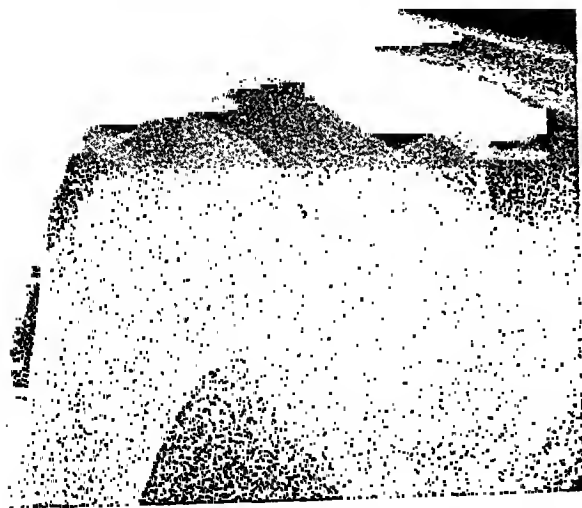


FIG. 3. Case 1. Twenty-two days following injury. Early signs of ossification are appearing in the conoid and trapezoid fasciculi.



FIG. 4. Case 1. Forty-eight days following injury. More extensive ossification has appeared but this is still more or less amorphous in character.



FIG. 5. Case 1. Ninety days after injury. Ossification is now complete.

days following injury, shows a moderate amount of amorphous, cloudlike material in the soft tissues beneath the outer end of the clavicle and persistence of separation of the joint with elevation of the clavicle. Forty-eight days after injury (Fig. 4), the soft tissue deposits are larger and denser, but the bone is still somewhat amorphous in character. Figures 5 and 6 are roentgenograms with and without weight bearing taken ninety-one days following injury. Well developed osseous masses are now noted in both fasciculi of the coracoclavicular ligament. On weight bearing, there is still slight elevation of the acromial end of the clavicle, but very little increased widening of the space be-



FIG. 6. Case I. Weight bearing. The acromioclavicular articulation is still lax but patient was asymptomatic.

tween the coracoid process and the clavicle. Subsequent roentgenograms showed no further change in the amount or appearance of the osseous deposits.

CASE II. This soldier, aged thirty-five, while on guard duty attempted to separate two soldiers who were fighting in the barracks. While so doing, he fell with one soldier on top of him, sustaining a complete dislocation of the right acromioclavicular articulation. His arm was immobilized in complete abduction for forty-eight hours and was then strapped in an attempt to reduce the separation. Figure 7 is a roentgenogram taken on the day of injury showing separation of the joint and elevation



FIG. 7. Case II. On day of injury. Roentgenogram demonstrates slight separation of the joint and elevation of the clavicle.



FIG. 8. Case II. Thirty days after injury. Amorphous ossification has appeared in both fasciculi of the coracoclavicular ligament.

of the acromial end of the clavicle. Figure 8 is a roentgenogram taken thirty days after injury. Rather abundant amorphous ossification has already appeared in both fasciculi of the coracoclavicular ligament. Figure 9 is a roentgenogram taken fifty-nine days after injury with the patient upright and bearing a 20 pound weight in his right hand. The acromial end of the clavicle is still elevated; ossification is now complete and while it is continuous with the clavicle above, there is a narrow space between the ossified portions of the ligament and the coracoid process.

At the time of this examination, the patient had no complaints, but experienced slight difficulty in lifting heavy objects.



FIG. 9. Case II. Fifty-nine days after injury with patient holding a 20 pound weight. Ossification is now complete; a narrow space exists between the ossified portions of the fasciculi and the coracoid process.

CASE III. A lieutenant, aged thirty-seven, was studied eight months following injury sustained while wrestling when he was thrown heavily, landing on his left shoulder. Roentgenogram on the day of injury (Fig. 10) shows separation of the joint but no elevation of the clavicle. He carried his arm in a sling for several weeks but his shoulder was not immobilized. During the next few months he had intermittent attacks of pain in the shoulder and when examined eight months following injury was unable to elevate his arm above horizontal. Roentgenography in the recumbent position (Fig. 11) showed marked ossification of the conoid fasciculus and slight ossification of the superolateral portion of the trapezoid fasciculus. Roentgenography in the upright position with a 20 pound weight in

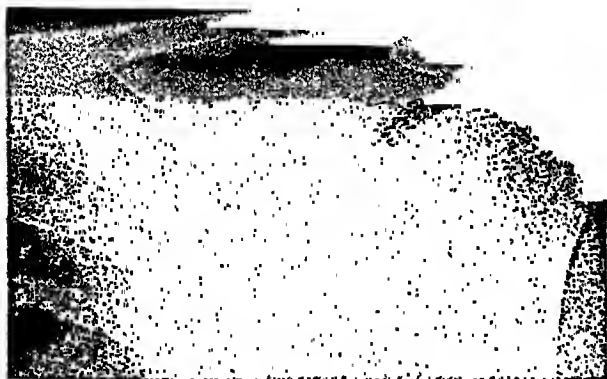


FIG. 10. Case III. On day of injury. There is moderate widening of the joint space but only slight elevation of the clavicle.



FIG. 11. Case III. Eight months after injury with patient recumbent. There is marked ossification of the conoid fasciculus and slight ossification of the superolateral portion of the trapezoid fasciculus.

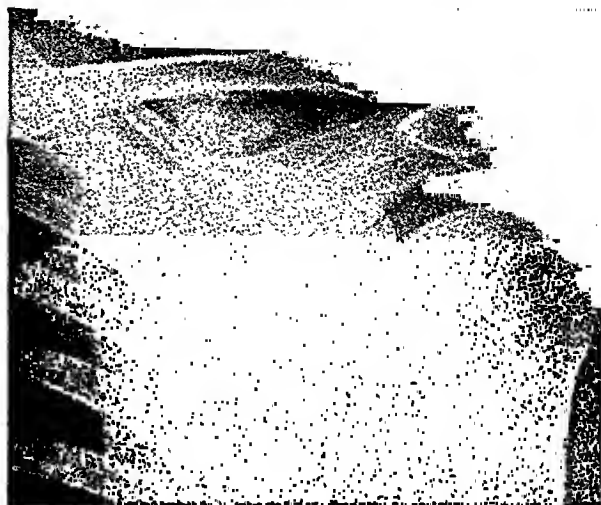


FIG. 12. Case III, same date. Patient is upright, bearing 20 pound weight in his hand. While the joint space widens, the clavicle is depressed, indicating at least partial restoration of continuity of the coracoclavicular ligament.



FIG. 13. Case III, same date. Left shoulder in abduction. Osseous masses are attached to the clavicle but not to the coracoid process.

the right hand (Fig. 12) shows widening of the joint space, but depression of the clavicle, indicating at least partial restoration of continuity of the coracoclavicular ligament. Roentgenography in abduction (Fig. 13) shows attachment of the osseous mass to the clavicle but not to the coracoid process.

CASE IV. This infantryman, aged thirty, was injured in a train wreck, sustaining a dislocation of his right acromioclavicular articulation, a fracture-dislocation of the cervical spine without paralysis and comminuted fractures of left tarsal bones. His shoulder was strapped for one month. When first seen in this hospital three

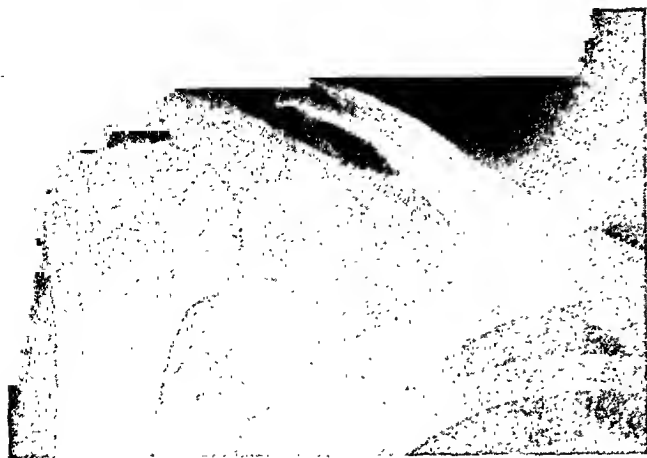


FIG. 14. Case IV. Three months after injury. Roentgenogram in recumbent position.

months later, he had no symptoms as far as his shoulder was concerned and full range of motion was present. At this time, roentgenograms in recumbent position (Fig. 14) and upright bearing a weight (Fig. 15) demonstrated bands of ossification in both fasciculi of the coracoclavicular ligament with attachment to the clavicle and coracoid process.

CASE V. A lieutenant, aged twenty-nine, was studied eleven months following an accident when he was thrown about 40 feet from a jeep, landing on his right shoulder. Roentgen examination of the shoulder revealed moderate separation of the acromioclavicular articulation. His shoulder was taped for four weeks and he then carried his arm in a sling for a few additional days. Three months following the

accident, roentgenograms showed extensive ossification of the coracoclavicular ligament and slight separation of the acromioclavicular articulation. At the time of examination, eleven months after injury, he had no complaints other than a feeling of slight weakness in the shoulder on pulling or lifting heavy objects. There was no limitation of motion and no tenderness. Roentgenography of the shoulder at this time (Fig. 16) showed discrete osseous deposits in both fasciculi of the coracoclavicular ligament but no separation of the joint or elevation of the clavicle. It seems probable that the complete recovery in this case may be credited, in part at least, to the ossification of the ligament.

CASE VI. This soldier, aged thirty-seven, had sustained a complete dislocation of the right acromioclavicular articulation in civilian life two years before, when he had slipped and



FIG. 16. Case v. Eleven months following injury. There are well developed osseous masses in the coracoclavicular ligament but there is no separation of the acromioclavicular articulation.

fallen, striking his shoulder against a railroad track. He was admitted to the hospital with a history of persistent pain in his right shoulder and inability to use his shoulder in such motions as lifting, pushing and pulling. Examination revealed moderate separation of the right acromioclavicular articulation with crepitus and painful motion of the shoulder joint. Roentgenogram of the right shoulder (Fig. 17) showed separation of the acromioclavicular articulation and osseous masses in both fasciculi of the coracoclavicular ligament. The patient was discharged from the service.

CASE VII. This soldier, aged twenty-five,



FIG. 15. Case IV. Patient upright and bearing 20 pound weight. Bands of ossification are noted in both fasciculi; the joint space is slightly wide but the clavicle is only slightly elevated. Patient was asymptomatic at this time.

slipped and fell from a step while carrying a box, striking his shoulder against a building. He experienced considerable pain in the region of the acromioclavicular joint. Roentgenogram of the shoulder with the patient recumbent revealed no abnormality, but roentgenogram in the upright position with a 20 pound weight in his hand (Fig. 18) showed slight separation of the joint and slight elevation of the acromial end of the



FIG. 17. Case vi. Two years following injury. Roentgenogram demonstrates slight widening of the joint space, slight elevation of the clavicle and multiple osseous masses in the coracoclavicular ligament.

clavicle. The dislocation was treated by adhesive strapping. Symptoms rapidly disappeared and he was returned to full duty two months after injury. Roentgenograms taken at this time showed no evidence of subclavicular ossification. This apparently represents a case of incomplete dislocation without avulsion of the coracoclavicular ligaments.

SUMMARY

1. Post-traumatic ossification of the coracoclavicular ligament is a common sequela of avulsion of this ligament associated with dislocation of the acromioclavicular articulation.

2. It is seen more commonly in dislocations which are classified clinically as complete.

3. The ossification appears three to six weeks following injury and becomes com-



FIG. 18. Case vii. Several days following injury. Roentgenogram taken in the upright position, the patient holding a 20 pound weight, shows slight separation of the joint and slight elevation of the clavicle. This patient did not develop ossification of the ligament and the dislocation was classified as incomplete.

plete about eight to ten weeks following injury.

4. If ossification has not appeared within six weeks following injury, it probably will not appear at a later date.

5. The ossification does not appear to contribute to the disability of patients, but may aid in restoring continuity of the damaged ligaments and in stabilizing the acromioclavicular articulation.

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REFERENCES

1. BOSWORTH, B. M. Acromioclavicular separation; new method of repair. *Surg., Gynec. & Obst.*, 1941, 73, 866-871.
2. CODMAN, E. A. *The Shoulder*. Thos. Todd Co., 1934.
3. LIBERSON, F. Role of the coracoclavicular ligaments in affections of the shoulder girdle. *Am. J. Surg.*, 1939, 44, 145-157.
4. MUMFORD, E. B. Acromioclavicular dislocation. *J. Bone & Joint Surg.*, 1941, 23, 799-802.
5. MURRAY, G. Fixation of dislocations of acromioclavicular joint and rupture of coracoclavicular ligaments. *Canad. M. A. J.*, 1940, 43, 270-271.
6. SPEED, KELLOGG. *A Textbook of Fractures and Dislocations*. Third edition. Lea & Febiger, Philadelphia, 1935, p. 259.

A STUDY OF LOWER EXTREMITY LENGTH INEQUALITY

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THE observations to be presented are those made by the study of 1,000 lumbosacral spines of soldiers examined in the X-Ray Department of the Regional Station Hospital of Fort Leonard Wood, Missouri. Most significant is the fact that the method of roentgenographic examination is unique, in that it institutes the use of a special machine devised by one of us (W.A.R.), and by the use of this machine

and illustrated in a paper¹ recently published.

The instrument is known as the spinal fixation and stabilization device. The roentgen-ray table is placed in the vertical position and the machine is brought up against it as seen in the illustration. The patient to be examined mounts the rotatable platform, standing on it in his stocking feet. He then is instructed to adjust a movable, centrally placed saddle so that it fits snugly into his crotch, thus assuring that he is centrally placed on the platform. An additional adjustable stabilization bracket is used to insure that the patient will stand as erect as is comfortably possible. This is accomplished by a bracket brought up to the patient's mouth, and on this bracket sterilized rubber tubing is placed and the patient is instructed to bite the tubing. The bracket is then pushed up into the position which holds the patient in an erect posture and it is then locked. The technician inspects the patient to be certain that both knees are held in the position of complete extension. The rotatable platform is then adjusted and locked so that the patient stands in an absolute anteroposterior presentation and the roentgenogram is made, using a 14 by 17 film size, so that the film will include the heads of both femurs, the entire lumbar and sacral spine, and a portion of the lower dorsal spine will be seen on the upper part of the roentgenogram. Then without moving, the patient is rotated by means of the rotatable platform so that it now is turned at 90 degrees and the patient is then presented for a true lateral view. A second, that is, lateral, roentgenogram is made in this position. This completes the roentgenographic study of the patient. As described in the original paper, it is again mentioned here that studies may be accomplished at any desired



FIG. 1. The spinal fixation and stabilization device with patient in position for the anteroposterior roentgenogram.

all spine studies have been made in an absolutely standardized upright position. An illustration of this device is seen in Figure 1. This device has been described

angle, according to the set of the rotatable platform, and by this means it is possible to visualize foramina, pedicles, articular facets, and any other portion of the spine best seen in the oblique views. By knowing such angles these views can be reproduced at any subsequent examinations. However, in this study, only the anteroposterior and lateral views were used.

By measurements and special tests it was determined that the lower edge, or border of a film taken in the upright position is absolutely parallel to the plane of the platform on which the patient stands. Accordingly, when the anteroposterior roentgenogram is examined, any difference in the level of the femoral heads as determined by measuring from the lower edge of the film to the uppermost portion of the femoral heads, may be taken to indicate a difference in lower extremity lengths. In addition to the determination that the lower border of the film is absolutely parallel to the plane of the platform of the stabilizing machine, a series of exposures were made on the same patient under variable conditions to determine possible sources of error. The patient was first examined as was routinely accomplished in this series, that is, the normal upright anteroposterior position. Then, while still standing in the anteroposterior position, he was instructed to attempt to tilt his pelvis by straining to one side and at the same time keeping both heels firmly on the platform. An additional exposure was made by repeating this procedure in which the patient attempted to tilt his pelvis to the opposite side. These roentgenograms were then examined and, by measurement, no differences were demonstrable. This would substantiate the absolute fixation of the stabilization device, and accordingly it is felt that the measurement which had been made may be accepted as reasonably accurate. In Figure 2, anteroposterior roentgenograms of three different patients are illustrated. *A* is one in which the femoral heads are of equal height when measured from the lower border of the film, and accordingly the right and left lower ex-

trémities on this patient are assumed to be of equal length. *B* illustrates a patient in whom the right lower extremity is shorter than the left as seen by mensuration, and *C* is of a patient in whom the left leg is shorter than the right.

The soldiers used in this study represent 1,000 consecutive, non-selected cases who were sent to the roentgen department because of a low back complaint and in every instance the roentgenograms were made by the use of the fixation device referred to above. In this study, all of the roentgenograms were reviewed first for the purpose of mensuration to determine the equality or amount of inequality between the lower extremities. All of the roentgenograms were then reviewed a second time for the purpose of determining existing pathology as seen roentgenographically. Each case was referred to by number in order that the result of each of these two reviews of the roentgenograms could be correlated. Tabulation of measurement as done in the first review and of roentgenographic pathology as done in the second review was carried out entirely separately in order that there would be no subconscious attempt on our part to correlate pathology with difference in extremity measurements. Only after the tabulations were completed was a correlation of the results made.

In tabulating what we refer to as leg length, the actual amount of difference between the height of the femoral heads is measured in millimeters. Tabulation was made on the basis of: (1) the right leg being shorter than the left, designating the amount, and (2) the left leg being shorter than the right, again indicating the amount.

For a reason, to be indicated later in this study, measurements were grouped on the basis of being 5 mm. or less and exceeding 5 mm. in amount. Differences as slight as 1 mm. were recorded. In one instance, a right lower extremity measured 38 mm. shorter than the left, and in another case a left lower extremity measured 44 mm. shorter than the right. These 2 cases represent the greatest extremes which were observed.

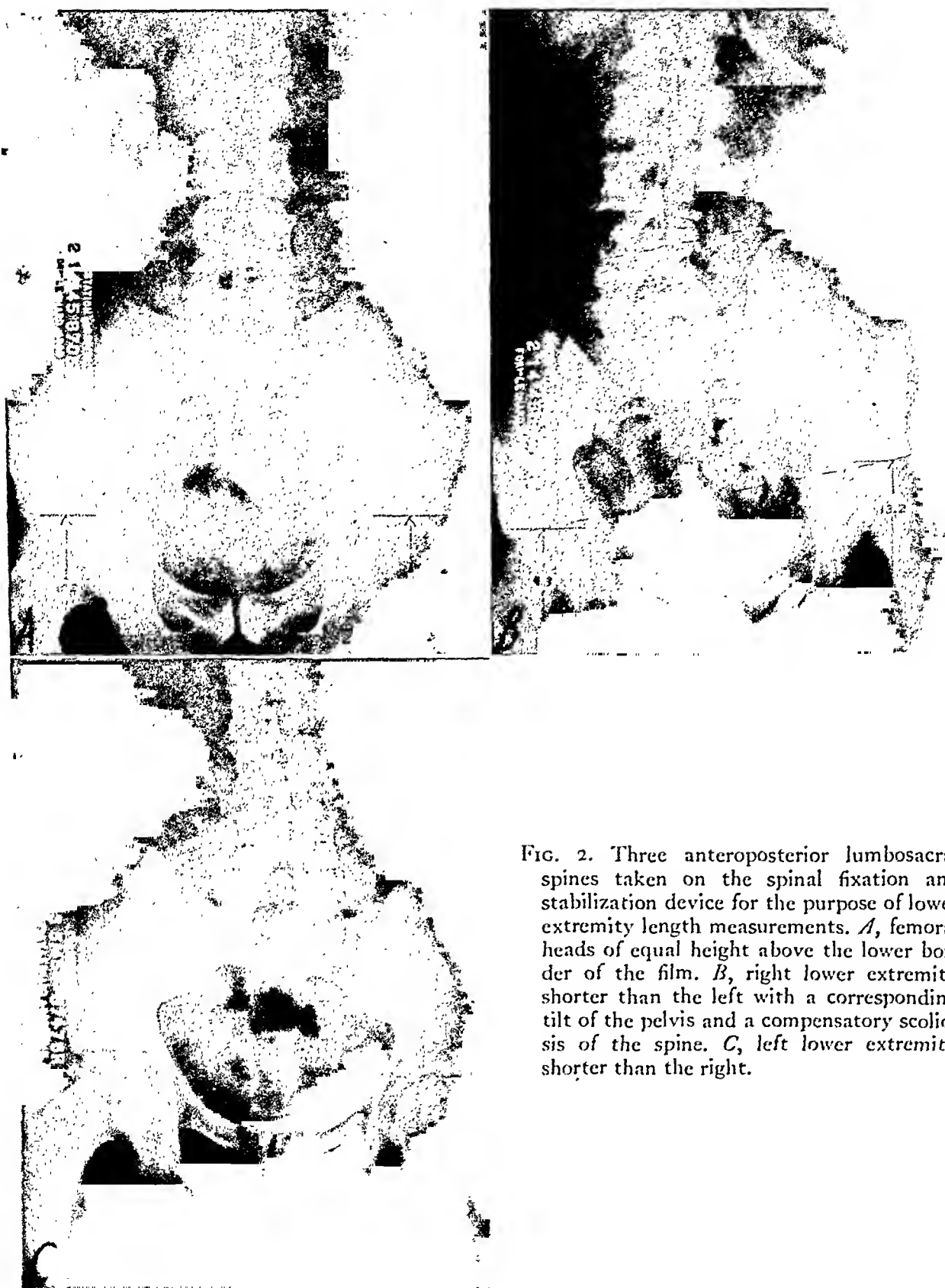


FIG. 2. Three anteroposterior lumbosacral spines taken on the spinal fixation and stabilization device for the purpose of lower extremity length measurements. *A*, femoral heads of equal height above the lower border of the film. *B*, right lower extremity shorter than the left with a corresponding tilt of the pelvis and a compensatory scoliosis of the spine. *C*, left lower extremity shorter than the right.

Table I gives the measurements obtained in the 1,000 cases reviewed. Only 230, or 23 per cent, of the cases had lower extremities of equal length. Of the 406 cases in which the right lower extremity is shorter than the

left, the average shortening in these 406 cases was found to be 7.47 mm. Of the remaining 364 cases which manifested shortening of the left lower extremity, the average shortening was found to be 6.50

mm. Of the 770 cases which showed shortening of the lower extremity, 395, or 51.30 per cent, had shortening of 5 mm. or less, while the remaining 375, or 48.70 per cent, had amounts of shortening which exceeded 5 mm.

As can be readily realized, whenever there exists a difference in the height of the femoral heads with apparent normal hip joints, that is, ruling out such conditions as dislocation, wandering acetabulum, and the like, there must necessarily be a tilt of the pelvis. As can be readily determined by measuring the height of the iliac crests, this tilt corresponds approximately to the difference in the height of the femoral heads. We have consistently observed ever since roentgenograms have been made in the upright position with the use of the stabilization device, that whenever there is such a pelvic tilt, there exists coincidentally a scoliosis of the lumbar spine (see Fig. 2 B). Because this scoliosis, in all instances, compensates for the tilt of the pelvis, it is referred to by us as compensatory scoliosis. The existence of this compensatory scoliosis in the presence of a tilted pelvis due to shortening of one or the other lower extremity is believed by us to have clinical significance and, furthermore, it is our opinion that the existence of any such condition cannot be determined with any degree of accuracy on gross physical examination. Furthermore, it becomes immediately apparent that the making of roentgenograms of the lumbosacral spine in the recumbent position, as is frequently done, completely prevents the discovery of such pathology as this.

In reviewing the 1,000 cases for roentgenological pathology, both the anteroposterior and the lateral views were carefully examined and all types of pathology were recorded. Because oblique views were not used, arthritic change in the apophyseal joints was not determined. Table II presents the various types of roentgenological pathology found and, as is apparent, the types have been classified on the basis of whether the patient had lower extremities of equal

or unequal length. Accordingly, since 63 patients of the 230 with extremities of equal length had a pathological condition, this represents 27.38 per cent. On the other hand, the 230 cases of roentgenological pathology in those patients who showed a difference in leg lengths, represents 29.74 per cent. This makes a difference of 2.36 per cent between the two groups showing pathology and because of this close ap-

TABLE I
MEASUREMENTS OF LOWER EXTREMITY LENGTHS
(1000 cases)

Lower Extremity Lengths	Millimeter Difference	Total Millimeter Difference	Number of Cases	Average Millimeter Difference
Equal	None	None	230	None
Right shorter than left	0-5	665	199	3.34
	6-10	963	119	8.09
	11-20	1128	78	14.47
	21 over	278	10	27.80
TOTAL		3034	406	7.47
Left shorter than right	0-5	604	196	3.08
	6-10	836	106	7.88
	11-20	739	55	13.43
	21 over	188	7	26.71
TOTAL		2367	364	6.50
TOTAL CASES			1000	

proximation, over 1,000 cases, one may assume that the existence of a difference in the lower extremity length has no correlation with the existence of roentgenological pathology. Inasmuch as the ratio between cases of equal lower extremities and of unequal lower extremities is approximately one to three, it can readily be seen that this ratio is fairly consistent in any one type of pathology listed. For example, if one were to refer to cases of spondylolisthesis, the ratio is seven to twenty for those of equal lower extremity lengths as of those of unequal lower extremity lengths which is approximately one to three. It will be noted that among the type of pathological conditions listed, there is a classification "structural scoliosis." It is felt that this deserves an additional word. Whenever a scoliosis was seen on the anteroposterior view which

TABLE II
PATHOLOGICAL CONDITIONS SEEN ON ROENTGENOGRAMS

Pathology on Roentgenogram			Equal Lower Extremi-	Unequal Lower Extremities			Total
				Right Shorter	Left Shorter	Total	
Sacroiliac joint arthritis	Right joint		1	4	3	7	8
	Left joint		7	6	6	12	19
	Bilateral		6	15	7	22	28
Existence of an anomalous joint between the transverse process of L-5 and sacrum	No arthritis	Rt. side	5	3	3	6	11
		Lt. side	3	8	7	15	18
		Bilateral	1	1	1	2	3
	With arthritis	Rt. side	0	2	2	4	4
		Lt. side	4	4	2	6	10
		Bilateral	0	1	0	1	1
Fusion between transverse process of L-5 and sacrum	Right side		0	0	2	2	2
	Left side		1	1	1	2	3
Spondylolisthetic lesions	Prespondylolisthesis		1	3	6	9	10
	Spondylolisthesis		7	8	12	20	27
	Reverse spondylolisthesis		2	3	1	4	6
Flat back (loss of normal lordosis)			7	13	5	18	25
Increased lumbosacral angle (above 50°) (elevated sacrum)			3	21	19	40	43
Asymmetry of articular facets of L-5			4	4	7	11	15
Structural scoliosis			6	4	4	8	14
Narrowed intervertebral disc space			1	7	2	9	10
Old compression fracture			2	1	4	5	7
Biconcave discs			0	9	6	15	15
Spina bifida (marked)			1	3	1	4	5
Osteoarthritis of the lumbar vertebra			0	2	1	3	3
Schmorl's nodes			1	1	1	2	3
Hemangioma of the lumbar vertebra			0	0	2	2	2
Anomalous joint between left transverse processes of L-2 and L-3			0	1	0	1	1
TOTAL			63	125	105	230	293
Complete Number of Cases			230	406	364	770	1000
Percentage with Pathology			27.38	30.78	28.84	29.74	29.30

existed and was not compensatory to any pelvic tilt and was due to another etiological factor, it was recorded as a structural scoliosis. Lacking in the table are the number of cases of compensatory scoliosis. As was pointed out previously, this condition existed whenever there was a difference in leg lengths. Furthermore, while no measurements were made to be presented in this

particular study, it was a general consistent observation that the degree of scoliosis was proportionate to the degree of pelvic tilt. This, of course, becomes an evident fact with the realization that an individual who has a shortened leg will have to compensate completely if he intends to hold the upper portion of his body erect or in the mid-sagittal plane. The 8 cases of structural

scoliosis listed in those instances in which there was a shortened lower extremity were apparent and were due in all instances to associated pathology such as bony change due to old trauma involving either the vertebral body, the articular facets, or the intervertebral disc. In these 8 cases the patient did not have a compensatory scoliosis and it was apparent on examining the patient physically that there was an abnormal gross curvature of the spine.

A further analysis and comparison of the tabulation of the lower extremity mensuration and roentgenological pathology manifests a factor which the authors believe to be significant. When the group manifesting a difference in lower extremity lengths in excess of 5 mm. are studied from the standpoint of pathology, it is found that of this group of 375 patients, only 93, or 24.80 per cent, give evidence of roentgenological pathology while the remaining 282, or 75.20 per cent, show no evidence of roentgenological pathology other than the leg shortening with the corresponding tilt of the pelvis and the compensatory scoliosis

TABLE III

CORRELATION OF PATHOLOGY AND LOWER EXTREMITY SHORTENING IN EXCESS OF 5 MILLIMETERS

Cases with Lower Extremity Shortening in Excess of 5 mm.	Number	Per Cent
With roentgenological pathology	93	24.80
Without roentgenological pathology	282	75.20
TOTAL	375	100.00

of the lumbar spine (see Table III). With the realization, as stated in the beginning of this paper, that every soldier has been examined from the roentgenological standpoint because he had a low back complaint, it is evident that marked differences, that is a difference exceeding 5 mm. between lower extremity lengths is apparently associated with a low back complaint or disability. In other words, of every 4

soldiers who have a low back complaint and who show an inequality in lower extremity length in excess of 5 mm., only 1 out of the 4 shows roentgenological change as listed

TABLE IV
MEASUREMENTS OF LOWER EXTREMITY LENGTHS
(100 Cases)

Lower Extremity Lengths	Milli-meter Difference	Total Milli-meter Difference	Number of Cases	Average Milli-meter Difference
Equal	None	None	29	None
Right shorter than left	0-5 6-10 11-20 21 over	74 151 35 0	19 19 3 0	3.89 6.10 11.66 0
TOTAL		260	41	6.34
Left shorter than right	0-5 6-10 11-20 21 over	56 74 11 0	19 10 1 0	2.94 6.80 11.00 0
TOTAL		141	30	4.70
TOTAL CASES			100	

in Table II which might account for the soldier's symptoms, or the remaining 3 show no such roentgenological change and only manifest shortening of leg with corresponding tilt of pelvis and the compensatory scoliosis of the lumbar spine. For this reason, it is our opinion that the existence of such a condition is significant from the standpoint of symptomatology and disability.

As stated at the beginning of this article, every one of these soldiers was examined because of a low back complaint. In order to make some comparison, a group of 100 general duty soldiers who gave no evidence of physical complaint was selected by company commanders and examined in a similar fashion. Mensuration of lower extremity lengths reveal that within this group 29, or 29 per cent, had legs of equal length as shown in Table IV. Of those

having a shortened lower extremity, 41 cases had shortened right lower extremities and 30 cases had shortened left lower extremities. As seen in Table IV the average millimeter difference for the shortened right lower extremity is 6.34 mm., and 4.70 mm. for the shortened left lower extremity. These averages are definitely less than those found for the 1,000 soldiers with back complaints (Table I).

Analyzing these 100 cases from the standpoint of pathology seen on the roentgenograms, it was found that only 8, or 8 per cent revealed any evidence of roentgenological pathology. As may be recalled (Table II), 293, or 29.30 per cent, had evidence of roentgenological pathology in the series of 1,000 cases with back complaint. Of the 8 cases with pathology seen, 4 were cases of structural scoliosis. The remaining 4 were cases in which an anomalous joint had formed between the transverse process of the fifth lumbar vertebra and the wing of the sacrum, and 1 of these 4 cases revealed evidence of arthritis within the anomalous joint. Further analysis of the 100 general duty soldiers reveals that there are 33 cases in which the difference in lower extremity length exceeds 5 mm. Of these only 1 showed any evidence of roentgenological pathology. It will be recalled (Table III) that a similar analysis in the group of 1,000 revealed that of the 375 cases with lower extremity shortening in excess of 5 mm., 93 had evidence of roentgenological pathology.

The observations presented here are not made for the purpose of drawing absolute conclusions. These are assumptions made by the authors based on a technique of roentgenography which we believe to be unique and has great practical value, and only after further additional careful studies and observations are made by the use of such, or similar technique, may any positive conclusions be drawn.

SUMMARY

Observations have been presented on a series of 1,000 lumbosacral spines examined

in the X-Ray Department of the Regional Station Hospital of Fort Leonard Wood, Missouri. The technique of examination is described and it is unique in that it utilizes a new stabilization device which necessitates that all lumbosacral spines be examined in the upright position. By this method it is possible to accurately measure differences in lower extremity lengths as manifested by a difference in the heights of the femoral heads.

The 1,000 cases were reviewed, both for the purpose of measuring difference in lower extremity lengths, and also from the standpoint of roentgenological pathology. Of the 1,000 cases 230, or 23 per cent, were found to have legs of equal length while the remaining 770, or 77 per cent, had lower extremities of unequal length. The average shortening of the right lower extremity was 7.47 mm. while the shortening of the left lower extremity was 6.50 mm.

The cases were reviewed for roentgenological pathology and it was found that of the 1,000 cases, 293, or 29.30 per cent had evidence of roentgenological pathology. Of this number, 63, or 27.38 per cent, were of the 230 cases of equal leg lengths, while 230, or 29.74 per cent were of the remaining 770 cases of unequal leg lengths.

A consistent observation which has been made is that in those cases with a shortened leg there is a corresponding tilt of the pelvis and a compensatory scoliosis of the lumbar spine. While the existence of roentgenological pathology does not seem to be correlated in any way with difference of leg lengths, it was found that in most cases with a difference in leg lengths in excess of 5 mm. and there were 375 such cases, only 93, or 24.80 per cent, had any roentgenological pathology while the remaining 282, or 75.20 per cent, had no roentgenological pathology other than the shortened leg with the corresponding tilt of the pelvis and the compensatory scoliosis of the lumbar spine. Since all of these had low back complaint it is possible that the remaining 75.20 per cent had complaint in association with the changes seen due to a shortened extremity.

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A similar analysis was done on 100 general duty soldiers who were selected by their company commanders as individuals who had no physical complaints. The analysis showed that a slightly greater percentage had legs of equal length and the average amount of difference of lower extremity lengths was definitely less than in the series of 1,000 cases with low back complaint. Furthermore, the amount showing any evidence of roentgenological pathology was small, being 8, or 8 per cent, as compared with 293, or 29.30 per cent, for the series of 1,000 cases. Finally, among the 100 general duty soldiers with lower extremity differences in excess of 5 mm. only one showed

any evidence of roentgenological pathology. It is not our intention to draw any absolute conclusions from this study, but simply to present this technique which we believe manifests changes which are not brought out by other roentgenographic technique. Before absolute conclusions can be drawn, further observations, studies and analyses must be made.

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REFERENCE

1. RUSH, W. A., Roentgenographic spinal fixation and stabilization device. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 54, 187-189.



LARGE SUBLINGUAL METALLIC FOREIGN BODY

REPORT OF A CASE

By MAJOR TED F. LEIGH, M.C.

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IN WARTIME it is natural that many cases with unusual findings will pass through the various departments of a hospital, and where trauma is the cause for complaint, the roentgen departments see all of them as a rule. We recently had a most unusual case in our Roentgen Department, and its findings were of extreme interest to us.

The patient was an enlisted man, aged twenty-one, gunner on a heavy bomber. While his plane was over the enemy target, an anti-aircraft shell burst near it; several fragments penetrated the plastic turret top where the patient was sitting, and one of these struck him in the mouth. His lips were cut, and several teeth were knocked loose. His tongue felt as though it was cut, and there was bulging under its left side, causing difficulty in expectorating the blood which accumulated, and in talking. He was unable to close his mouth completely. There was little pain. His mates on the bomber gave him first aid consisting of morphine, sulfanilimide crystals locally to the lips, a

bandage to the mouth, and oxygen from the plane's supply.

On return from the mission to this base some four hours later, he was admitted to this hospital. Examination made in the Receiving Office showed the lower lip to have a deep cut in its mid-portion, and the upper to be nicked. There was a cut in the tongue for approximately 1 cm. of its length in the anterior portion on the left. Three of the front teeth were missing from their sockets—the upper right central incisor, and both lower central incisors. Two of these teeth were found lying loose anterior to the tongue and were lifted out. Several of the roots of these teeth were fractured and were seen still in their sockets, but loose. The patient was unable to completely close the mouth. He was having difficulty in expectorating the mixture of blood and sputum which accumulated.

Roentgenograms were made of the mandible and mouth region in posteroanterior, right and left lateral positions. An additional roentgenogram was made in the verticosubmental position, and occlusal films of the anterior teeth were exposed. These roentgenograms showed a very large metallic foreign body lying in a more or less horizontal plane in the left sublingual region of the mouth; its long diameter was directed in an almost true anteroposterior direction. By actual measurement following removal this foreign body was 5.3 cm. in length and 3 cm. in

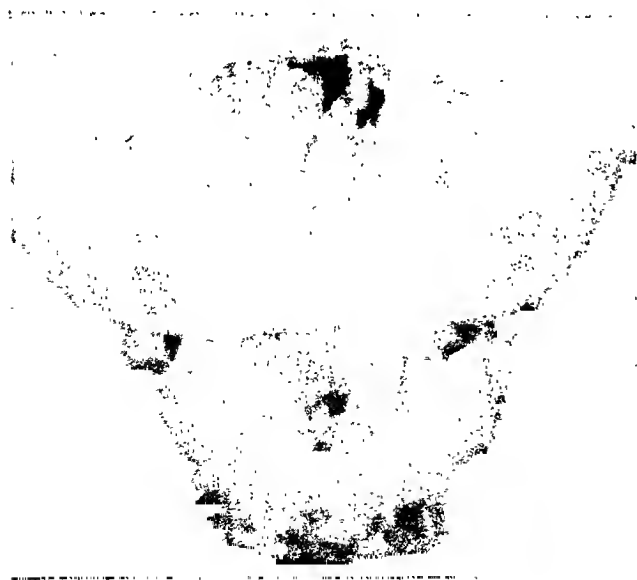


FIG. 1. Posteroanterior view of mandible showing large foreign body. The anterior portion of the mandible shows a concave fracture line at the symphysis, and several anterior teeth missing.



FIG. 2. Left and right lateral views of mouth, showing the jagged nature of the foreign body. Its size is best seen on these views.

width. Its edges were jagged. Several other opaque shadows, small in size, and seen best on lateral view, appeared to be fillings in teeth. The occlusal roentgenograms showed several of the front teeth missing, but a few of their roots remaining, as had been seen on physical examination. There was a small area of bone scooped out of the upper border of the mandible in its anterior portion. There were no gross fractures of the mandible or of the maxilla.

The patient was taken to the operating room, and under local anesthesia, the large foreign body was removed. There was no difficulty experienced by the surgeon in removing it, although it lay deep in the floor of the mouth and was entirely covered by the soft tissues. Several small bits of bone were attached to the metallic body, and in addition, several tooth fragments came out of the sublingual region on irrigation. The remaining tooth roots were extracted. Sutures were taken in the lower lip and in the upper gum. The sublingual wound was not closed.

Following operation, the patient was given mouth washes, and during the ten days he was observed here prior to his removal to a rear area hospital, his course was uneventful.

Two findings in this case were of especial interest to us. One was the unusual size of the metallic foreign body, particularly when compared to the relative size of the body part in which it was lodged. The other was the minimal amount of trauma done to the soft tissues, teeth and mandible when the foreign body entered the mouth. Our conception of this finding was that the

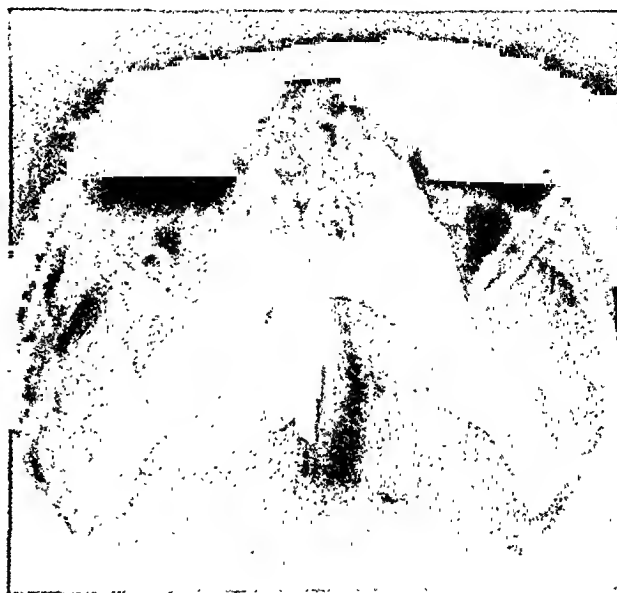


FIG. 3. Verticosubmental view. The foreign body lies to the left of the midline.

patient must have had his mouth open at the time the fragment penetrated, a condition which he cannot recall due to the heat of battle at the moment, and that the foreign body must have entered in about the same plane in which it was found, which would present its smallest diameter to the oral aperture. Otherwise, we believe that the soft tissues and mandible would have sustained far greater trauma than they did.

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THE ROENTGEN TREATMENT OF BURSITIS OF THE SHOULDER*

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ROENTGEN therapy has been used for bursitis of the shoulder for a sufficiently long time to establish it as one of several recognized forms of treatment. Many papers, especially those by Lattman,¹⁰ de Lorimier,⁵ Sandström,¹² Herrman,⁷ Jones,⁸ Pendergrass and Hodes,¹¹ Baird,¹ Klein and Klemes,⁹ Chapman,⁴ Harris,⁶ Brewer and Zink,² and Borak,³ stress the results from roentgen therapy, so valuable information concerning its therapeutic effects is available in the literature.

This paper is based on the results obtained in 87 patients with bursitis of the

tion period was unnecessarily long in many cases, it afforded an opportunity to obtain valuable information about recurrences and allowed the examining physician to check previous statements of the patient in regard to the effect of the radiation.[†]

The cases were placed in one of three categories, depending upon the duration of the symptoms. Those with symptoms for one week or less were classified under the heading, acute bursitis. The designation, subacute, applies to patients with pain and shoulder disability lasting more than a week and as long as two months. When the complaints were of longer duration than two months, they were considered as chronic in nature.

Table 1 shows the incidence of the three forms of bursitis in the various age periods. In each of the three groups, females predominate. In fact, in the group with chronic disease, the ratio is two to one. Fifty-six of the total of 87 patients are females.

Before the institution of roentgen treatment, a real effort was made to establish a diagnosis by obtaining a careful history and evaluating it with the clinical and roentgen findings. The clinical findings in the acute form are characterized by agonizing pain in the shoulder, aggravated by the slightest motion of the arm. In the three types, the pain is usually worse at night and becomes excruciating when the patient inadvertently rolls on the affected shoulder while in bed. In the usual so-called subdeltoid form, the discomfort is particularly marked over the greater tubercle and it may radiate in all directions from this area. Point tenderness is elicited in the greater

† Dr. W. Edward Chamberlain and I are indebted to our Consultant in Oncology, Dr. John V. Blady, for the organization of the follow-up clinic which has made it possible for me to report these cases.

TABLE I

BURSITIS—AGE INCIDENCE

25-29	30-39	40-49	50-59	60-69	70-79	80+	Total
Acute							
1	6	1	4	4			16
Subacute							
2		8	6	6	1		23
Chronic							
3	7	13	18	6		1	48
Grand Total							
6	13	22	28	16	1	1	87

shoulder, treated in the Roentgen Therapy Department of the Temple University Hospital, principally during the past six years. More than this number received treatment during this time, but only those with complete follow-up records were selected for this study. In order to be certain that the data concerning the effect of the treatment are reliable, the patients were followed for many months in the out-patient department. Although the observa-

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tubercle region and there may be evidence of local heat and swelling. The motion of the arm is greatly limited and attempts to rotate or abduct it cause the patient severe pain. Less severe pain but considerable restriction in motion is found in the subacute and chronic forms.

In the subacute and chronic forms, the diagnosis is often more difficult. It is important to obtain as much information as possible about the general condition of the patient because chronic shoulder pain is often on the basis of disease other than bursitis. Recent and old fracture, arthritis of the cervical spine and shoulder, brachial neuritis, coronary artery disease with angina, occupational strain and primary and metastatic bone disease are some of the conditions that produce shoulder pain simulating bursitis. Radiation therapy produces a mildly favorable transitory effect or no benefit at all in a painful shoulder due to any one of the above-mentioned abnormalities. Although little is expected from the use of radiation when the shoulder pain is on the basis of one of the above-mentioned conditions, treatment is usually inevitable once the diagnosis of bursitis and the possible benefit of roentgen therapy is suggested to the patient.

Roentgen examination of the shoulder is a necessary preliminary procedure, especially in the chronic type, to rule out or establish the presence of arthritis, old and recent fracture, osteoporosis, primary and metastatic bone disease, and calcification in the soft tissues adjacent to the head of the humerus.

In the past, considerable emphasis has been placed on the importance of calcification in the soft tissues in the diagnosis of bursitis of the shoulder, yet, experience indicates that the history and clinical findings are much more reliable in the evaluation of active disease than the demonstration of calcium deposits by roentgen examination. Interpreted in a strict sense, the presence of calcium deposits indicates previous inflammatory or degenerative disease in the tendon or bursa, but is unreliable evidence

of active disease since in many patients the calcification is present without symptoms while others with severe symptoms are negative for calcifications. Experience in the past indicates that favorable results with irradiation are not influenced by the presence of calcification and are not dependent on the disappearance of calcium deposits, so no attempt was made to determine the length of stay of the calcium in the tissues after treatment.

The usual site of the calcium deposits is adjacent to the greater tubercle of the humerus in the tendon of the supraspinatus muscle, but occasionally they are found elsewhere in the soft tissues in the neighborhood of the head of the humerus. Supplementing the usual stereoscopic study of the shoulder with anteroposterior roentgenograms, exposed with the arm internally and externally rotated, increases the incidence of positive findings. The incidence of calcification in the affected shoulder in this series of 87 patients is 43.6 per cent. The percentage of patients with calcium deposits in the affected shoulder is practically the same in the three groups, there being a variation of only 0.4 per cent, as revealed by Tables II, III and IV.

The physical factors employed in the treatment are 180 kv. (av.) constant potential, 8 ma., 0.5 mm. of copper plus 1 mm. of aluminum filter and 50 cm. target-skin distance. With few exceptions, the individual dose was 150 r, measured in air, at the skin without backscatter, delivered through one field either 10 by 15 or 15 by 15 cm. in size. The beam was either directed to the anterior or anterolateral aspect of the shoulder, depending upon the size or site of the involved area.

Most of the acute cases received from one to three daily doses with an additional dose in one week if necessary. Several in this group of 16 were completely relieved by a single dose and a few needed only two treatments. Many of the 23 patients with subacute manifestations were treated twice a week for two weeks for a total of four treatments. A few received 150 r daily for

TABLE II
ACUTE BURSTITIS
Pain 1 week or less before treatment

Complete relief—14	10—Relief in week or less (5 of these well in 3 days or less) 4—Relief in 10–14 days—Well in 3 weeks or less
Poor result—2	1—Prompt relief but pain recurred in 3 weeks 1—Slight relief only
Treated—16	

Calcification in 7 of 16 or 43.7 per cent

three days and a fourth treatment in one week.

Forty-eight patients with chronic shoulder pain were treated in one of three ways, depending upon the severity of the symptoms and the choice of methods by the radiologist administering the therapy. Twenty-nine were treated twice a week for two weeks, 11 received weekly doses usually for four weeks, and in 8, doses were administered on three consecutive days with a fourth treatment in one week's time. As far as it is possible to determine, the interval between treatments made no difference in the results in the patients with chronic disease.

The results in 14 of the 16 patients with acute symptoms, one week or less, were excellent, as indicated by Table II. Ten of the 14 were completely relieved of pain in one week and of these, 5 were well in three days. The additional 4 reported a cure in three weeks or less, with marked relief of symptoms from ten days to two weeks. The 2 remaining cases did not respond well to treatment. One obtained a prompt response but the pain recurred in three weeks, while the other reported some alleviation of the acute symptoms but persistence of mild pain for many days following the treatment.

The responses in 19 of the 23 patients with subacute symptoms were good but not as prompt as seen in the acute cases (see Table III). Six were well in one week or less

and the majority of the remaining 13 reported considerable relief of the pain after treatment, with persistence of mild symptoms for about two weeks. In 2 of the 13, symptoms lasted for as long as two months. Four patients in the subacute group failed to respond satisfactorily to treatment (Table III).

Roentgen therapy yields relatively poor results in chronic bursitis, as shown by Table IV. In 16 of 48 cases, or 33½ per cent, a good result was obtained. When favorable, the response was slower than that noted in acute and subacute bursitis, but most of those patients who were benefited reported relief and then disappearance of pain in from three to six weeks. A few were completely relieved in less than three weeks. In some, there was residual limitation of motion estimated as slight, possibly on the basis of adhesions or other inflammatory disease changes. Ten of the patients obtained a temporary relief but the pain recurred in from one to nine months. Usually, the pain relief lasted from two to six weeks, but in a few the result was of longer duration. Perhaps these results could be classified as partial relief, but, when the patients were interviewed months after the treatment, they considered the treatments ineffectual since the pain recurred. The remaining 22 were not benefited at all by the treatment. A careful

TABLE III
SUBACUTE BURSTITIS
Pain 2 months or less before treatment

Complete relief—19	6—Well in 1 week or less 10—Prompt improvement but mild pain, 2 weeks 1—Pain relief in 3 weeks 2—Mild pain lasted 2 months
Poor result—4	1—Relief for 2 weeks, recurrence 1—Relief—3 mo., recurrence 1—Slight improvement? 1—No benefit
Total—23	

Calcification in 10 of 23 or 43.4 per cent

study of this group showed that in some of them the shoulder pain was on some other basis than bursitis. Since it was not feasible to defer the treatment long enough to adequately study the patients with atypical shoulder pain, they were treated and the negative results classed as failures.

TABLE IV
CHRONIC BURSITIS

Pain longer than two months before treatment.	
Complete relief—16	4—Relief 1 month or less 3—Relief 6 weeks or less 9—Exact duration of pain after treatment not known; follow-up indicated complete relief
Poor result—10	9—Relief only 2 months 1—Relief only 9 months
No result—22	No relief from pain
Total—48	

Calcification in 21 of 48 or 43.7 per cent

To determine whether the responses differed in those patients classified as acute and subacute whose history was negative for previous attacks of bursitis from those with a positive history for previous episodes, another grouping was made, termed recurrent. Only 9 patients make up this group. All were pain free from time of the previous attack of bursitis that occurred a number of months or several years ago until the present one. Some of this group sought roentgen therapy because they previously obtained relief from its use, while others recovered spontaneously from a previous attack or were treated by other methods. With one exception, the responses in this group were good so the results are comparable to those obtained in patients who never experienced previous attacks. The results are included with the conventional acute and subacute cases so the recurrent group is not a separate one as far as the statistics are concerned.

SUMMARY AND CONCLUSIONS

The results obtained with roentgen therapy in eighty-seven patients treated for bursitis of the shoulder indicate that it is a valuable form of treatment for those cases with acute and subacute manifestations of the disease. All but two of the patients with acute bursitis were relieved of pain, and the majority were well in one week or less. The responses in the subacute group were not as prompt, but more than two-thirds reported complete relief of pain in two weeks or less and only a few were not benefited. Only one-third of the group with chronic symptoms were cured, and almost 50 per cent reported no relief of pain.

The relatively poor results with chronic bursitis may be due in part either to adhesions or inflammatory soft tissue changes and to a lesser degree to an erroneous initial diagnosis. The numerous causes for chronic shoulder pain simulating bursitis, and the lack of response of most of these conditions to roentgen therapy, emphasize the necessity for careful clinical and roentgen examinations before the decision is reached to administer treatment.

The presence of calcium in the soft tissues of the shoulder is of lesser importance than the history and clinical findings in the diagnosis of bursitis. The incidence of calcification in the affected shoulder of the patients in this series is 43.6 per cent. Since favorable results with roentgen therapy are not dependent on the disappearance of calcium deposits, no attempt was made to determine their length of stay in the tissues after treatment.

The results with recurrent bursitis are comparable to those obtained in patients with an initial attack, so irradiation should not be withheld from a patient with acute or subacute bursitis simply because the history indicates an episode of the disease at some time in the past. However, the lack of response when dealing with chronic bursitis is sufficient reason to withhold further irradiation as none of the patients in this group benefited from a second series when

the results from the first series were indeterminate or poor.

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REFERENCES

1. BAIRD, L. W. Roentgen irradiation of calcareous deposits about the shoulder. *Radiology*, 1941, 37, 316-324.
2. BREWER, A. A., and ZINK, O. C. Radiation therapy of acute subdeltoid bursitis. *J.A.M.A.*, 1943, 122, 800-801.
3. BORAK, J. Tendogenetic disease and its treatment with x-rays. *New York State M. J.*, 1945, 45, 725-729.
4. CHAPMAN, J. F. Subacromial bursitis and supraspinatus tendinitis; its roentgen treatment. *California & West Med.*, 1942, 56, 248-251.
5. DE LORIMIER, A. A. Roentgen therapy in acute para-arthritis. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1937, 38, 178-195.
6. HARRIS, J. H. Roentgen treatment of acute bursitis of the shoulder. *Pennsylvania M. J.*, 1943, 46, 683-684.
7. HERRMAN, W. G. Value of roentgen therapy in acute subacromial bursitis. *J. M. Soc. New Jersey*, 1939, 36, 529-532.
8. JONES, O. O. X-ray treatment of subacromial bursitis. *New Orleans M. & S. J.*, 1941, 93, 363-366.
9. KLEIN, I., and KLEMES, I. S. Treatment of peritendinitis calcarea in the shoulder joint. *Radiology*, 1941, 37, 325-330.
10. LATTMAN, I. Treatment of subacromial bursitis by roentgen irradiation. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1936, 36, 55-60.
11. PENDERGRASS, E. P., and HODES, P. J. Roentgen irradiation in the treatment of inflammations. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1941, 45, 74-106.
12. SANDSTRÖM, C. Peritendinitis calcarea. A common disease of middle life: Its diagnosis, pathology and treatment. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1938, 40, 1-21.



IRRADIATION SICKNESS IN RATS*

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INTRODUCTION

IT IS well known that the welfare of many persons with tumors, leukemia, and various types of dermatitis is dependent upon the administration of sufficient roentgen-ray dosage to control the condition. But severe irradiation sickness often makes it difficult to give adequate therapy. The action of radiation on living matter is of such complexity that treatment for the prevention of irradiation sickness has remained of necessity on a nonspecific basis. There is no known mechanism by which the physician can be certain of protecting every atom and molecule of body tissue. The living tissue protoplasm is a complex material consisting of water, proteins, lipoids, carbohydrates, electrolytes, enzymes, hormones, and perhaps many other organic compounds. Each cell of the human body is an exceedingly complicated unit of physico-chemical equilibrium. During irradiation manifold chemical changes are produced in regions where the energy quanta are absorbed. With large dosage, disorganization of the cell constituents results and significant effects, both beneficial and detrimental to the patients, are produced. These radiobiologic reactions are largely determined by the size of the dose, the quality of the wavelength of radiation, and the frequency and manner of its application.

In the Nutrition Clinic in Birmingham, Alabama, the problem of irradiation sickness has been one of great interest for seven years. Our studies^{1,2} have made the use of

careful dietary and vitamin therapy seem logical, if on empiric grounds alone, since nutrition is often deranged in persons needing radiotherapy. Accordingly, it was desired to determine more specifically the importance of the nutritional level and the value of various dietary and parenteral supplements. Rats were chosen for the study of irradiation sickness reported in this communication since they so closely resemble human beings in many nutritional and metabolic characteristics and since they enable more adequately controlled experiments.

MATERIALS AND METHODS

For this study, which has been carried out over a period of eighteen months, 824 Sprague-Dawley albino weanling rats were used in the twenty experiments, usually in groups of fifty-two. The experiments were begun when the rats were twenty-six to twenty-nine days old. They were continued until the rats were from fifty-four to ninety-five days old. The rats were housed in individual cages, and daily individual weight records were kept. Each rat was provided with the prescribed diet and with water *ad libitum*. Adequate control groups which were not exposed to roentgen radiation were used to parallel fully the test conditions in each experiment.

The test rats were given a single massive dose of radiotherapy varying from 600 roentgens to 800 roentgens in the different experiments. The factors used were 200 kv. or 210 kv., 15 ma. or 20 ma., 50 cm. distance, 0.5 copper and 1 mm. aluminum filter, and a 20 by 20 cm. cone. For this exposure the rats were arranged in wooden boxes 20 by 20 cm. which were divided into

¹ Bean, W. B., Vilter, R. W., and Spies, T. D. Effect of roentgen-ray on the blood codehydrogenases I and II. *Ann. Int. Med.*, 1939, 13, 783-786.

² Bean, W. B., Spies, T. D., and Vilter, R. W. Note on irradiation sickness. *Am. J. M. Sc.*, 1944, 208, 46-54.

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eight equal compartments. One rat was placed in each compartment and the box was covered with a wire screen. The compartments were of such a size that the rats were able to assume any elongated position; hence it is thought that the total irradiation was fairly uniform over the entire surface of the body. The roentgen dosage was measured by means of an integron placed directly above the box containing the rats. It was necessary to determine the critical dosage level for each set of experimental conditions so that approximately one-half of the rats would die and the other half would survive the irradiation. At the time of the roentgen treatment the age of the group of rats in the different experiments varied from thirty-eight days to ninety-one days. It was necessary to employ a massive dose of roentgen rays in order to obtain objective criteria for the incidence and severity of irradiation sickness. Those criteria used were percentage fatality, post roentgen therapy survival time, weight changes, observations on activity and food consumption.

In these experiments various diets were employed in order to establish different nutritional levels. The nutritionally complete diet consisted of Purina Dog Chow Checkers *ad libitum* (stock diet). In some cases this diet was limited in amount to 5 gm. daily, which was the quantity found experimentally to produce approximately balanced metabolism so that no appreciable weight changes occurred from day to day. Two essentially similar vitamin-free diets were also used in various experiments.

Vitamin-free Diet A

Cornstarch	68%
Vitamin-test casein	18%
Lard	10%
Salts (U.S.P. salt mixture 11)	4%

Vitamin-free Diet B

Sucrose	68%
Vitamin-test casein	18%
Vegetable oil	10%
Salts (U.S.P. salt mixture 11)	4%

The U.S.P. salt mixture 11 had the following composition:

Sodium chloride (U.S.P.)	4.35%
Magnesium sulfate (U.S.P.)	13.70%
Sodium biphosphate (U.S.P.)	8.72%
Potassium phosphate (K_2HPO_4)	23.98%
Calcium biphosphate $CaH_4(PO_4)_2 \cdot H_2O$	13.58%
Ferric citrate (U.S.P. reagent 17.5% Fe)	2.97%
Calcium lactate (U.S.P.)	32.70%

The value of daily oral vitamin supplements to the vitamin-free diet A was studied by administering them three days before the roentgen treatment and continuing daily thereafter until the termination of the experiment. The following daily supplements were dissolved in 5 cc. of water and added to each rat's usual vitamin-free diet:

Thiamine	0.2 mg.
Pyridoxine	0.2 mg.
Inositol	0.2 mg.
Riboflavin	0.2 mg.
Nicotinamide	2.5 mg.
Calcium pantothenate	10.0 mg.
Choline hydrochloride	20.0 mg.

Each rat was also given daily 0.5 cc. of a cod liver oil preparation which contained 850 U.S.P. units of vitamin A and 85 U.S.P. units of vitamin D per gram.

Parenteral medications which were tested were:

- Vitamin B₆—in daily intraperitoneal doses of 0.5 mg. and 1.0 mg. dissolved in saline
- Vitamin K—in daily intraperitoneal doses of 0.01 mg. and 0.1 mg. dissolved in saline
- Thiamine and nicotinamide—in daily intraperitoneal doses of 0.5 mg. each dissolved in saline
- Folic acid—in daily subcutaneous doses of 25 micrograms dissolved in saline and sodium bicarbonate solution.
- Crude liver extract (Lilly, 1 U.S.P. unit per cc.)—in three subcutaneous doses of 0.2 cc., the first two days before the roentgen treatment, the second immediately after the roentgen treatment, and the third two days after the treatment.

With the exception of the crude liver extract, which was given in three single doses, all the parenteral medications were begun two days before the roentgen treatment and continued daily thereafter until the termination of the experiment. Control groups receiving saline injections were used to parallel each of the groups receiving any parenteral medication.

TABLE I
IRRADIATION SICKNESS IN RATS—RESULTS OF EXPERIMENTS XIX AND XX

Group	Num-ber of Rats	Diet	Medica-tion	Dosage (roent-gens)	Experimental Days																																		Total Deaths	Per Cent Fatality																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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X = rat died.

RESULTS

Of the twenty experiments carried out, the results of the most significant ones will be reported. Experiments XI, XIX, and XX were of especial interest and are reported in detail in Figures 1-6 and in Table I.

It was necessary to determine the critical roentgen-ray dosage level at which approximately one-half of the rats died within three weeks after the radiation exposure. Depending on the age of the rats, temperature and other experimental conditions, this dosage level was either 650 roentgens or 700 roentgens. Older rats were found to withstand the roentgen-ray exposure better than younger ones.

Forty-four and forty-six day old rats maintained on a vitamin-free diet were exposed to 650 r on the twentieth experimental day. They were given three doses of 0.2 cc. of Lilly crude liver extract (1 U.S.P. unit per cc.), the first dose two days before, the second dose the day of, and the third dose two days after the roentgen-ray exposure. These subcutaneous injections gave no indication of protective value against irradiation sickness.

Rats maintained on a stock diet were given intraperitoneal injections of 0.01 mg. or 0.1 mg. of vitamin K dissolved in 0.5 cc. of saline daily, beginning two days before the exposure to 700 r. These different groups of rats were 37, 42, 49, 56, and 60 days old at the time of the roentgen irradiation. This medication gave no significant evidence of prophylactic or therapeutic value in irradiation sickness. Intraperitoneal injections of 0.5 mg. or 1.0 mg. of pyridoxine (vitamin B₆) in other groups of rats under the same test conditions showed possible protective value. The evidence, however, was not statistically sufficient to warrant a definite statement.

Similarly, daily intraperitoneal doses of a combination of 0.5 mg. of thiamine and 0.5 mg. of nicotinamide dissolved in 0.2 cc. of saline gave no statistically significant evidence of protective value, though the results indicated such a trend. This medication was given to rats maintained on stock

diet and exposed to 700 r when thirty-eight days old.

Folic acid in daily subcutaneous doses of 25 micrograms dissolved in 0.2 cc. of saline and sodium bicarbonate solution also gave evidence of a trend towards possible protective value. This medication was tested on rats exposed to 700 r when thirty-eight days

on a vitamin-free diet as compared with those maintained on a limited amount of stock diet (5 gm.). The importance of the nutritional status of a rat in determining the degree of irradiation sickness following exposure to roentgen radiation is also shown in Experiment XI. In addition, this experiment demonstrates the value of daily oral

TABLE II
MEDICATIONS TESTED FOR PROTECTIVE VALUE AGAINST IRRADIATION SICKNESS IN RATS

Diet	Roentgen-Ray Exposure		Medication	Protective Value
	Age of Rat (in days)	Dosage (roentgens)		
Vitamin-free	44 or 46	650	Crude liver extract—three doses, 0.2 cc. subcutaneously	0
Stock	37, 42, 49, 56, or 60	700	Vitamin K—daily, 0.01 mg. or 0.1 mg. intraperitoneally	0
Stock	37, 42, 49, 56, or 60	700	Pyridoxine—daily, 0.5 mg. or 1.0 mg. intraperitoneally	+(?)
Stock	38	700	Thiamine and nicotinamide—daily, 0.5 mg. each intraperitoneally	+(?)
Vitamin-free	38	700	Folic acid—daily, 25 micrograms subcutaneously	+(?)
Vitamin-free	48	650	Daily oral supplements: Thiamine 0.2 mg. Pyridoxine 0.2 mg. Inositol 0.2 mg. Riboflavin 0.2 mg. Nicotinamide 2.5 mg. Calcium pantothenate 10.0 mg. Choline hydrochloride 20.0 mg.	+

of age. The rats were maintained on a vitamin-free diet *ad libitum* or on the stock diet in an amount limited to 5 gm. This quantity of stock diet was found to maintain fairly balanced metabolism with minimal weight changes. Table I shows the results of the testing of folic acid in Experiments XIX and XX. These two experiments are reported together since they were in every way identical.

Experiments XIX and XX (Table I) clearly demonstrate also the increased incidence of fatal irradiation sickness in rats maintained

vitamin supplements of thiamine, pyridoxine, inositol, riboflavin, nicotinamide, calcium pantothenate, and choline hydrochloride, beginning three days prior to the roentgen-ray exposure. Previously these rats were maintained solely on a vitamin-free diet. On the twentieth experimental day, when these rats were forty-eight days old, they were given 650 r. Figures 1-6 show the weight curves and fatalities for each of the groups of rats in this experiment. The striking difference in the incidence of fatal irradiation sickness between those rats on

the vitamin-free diet and those on the stock diet is clearly shown. In groups 2A and 2B, which are identical, the value of the oral vitamin supplements is demonstrated in that the number of fatalities is so markedly diminished. Table II presents a summary of the protective value in irradiation sickness of the medications tested.

In Experiment XI there was a considerable difference in size between the rats on the vitamin-free diet, and those on the unlimited stock diet. The rats on the stock

tion so that there can be no question of the fact that the dosage received by the rats of all the groups was the same. Since the results of all these experiments are corroborative, Experiment XI may still be considered significant in spite of the difference in size of the rats in different groups at the time of roentgen irradiation.

DISCUSSION

The difference in the incidence and severity of irradiation sickness in rats of

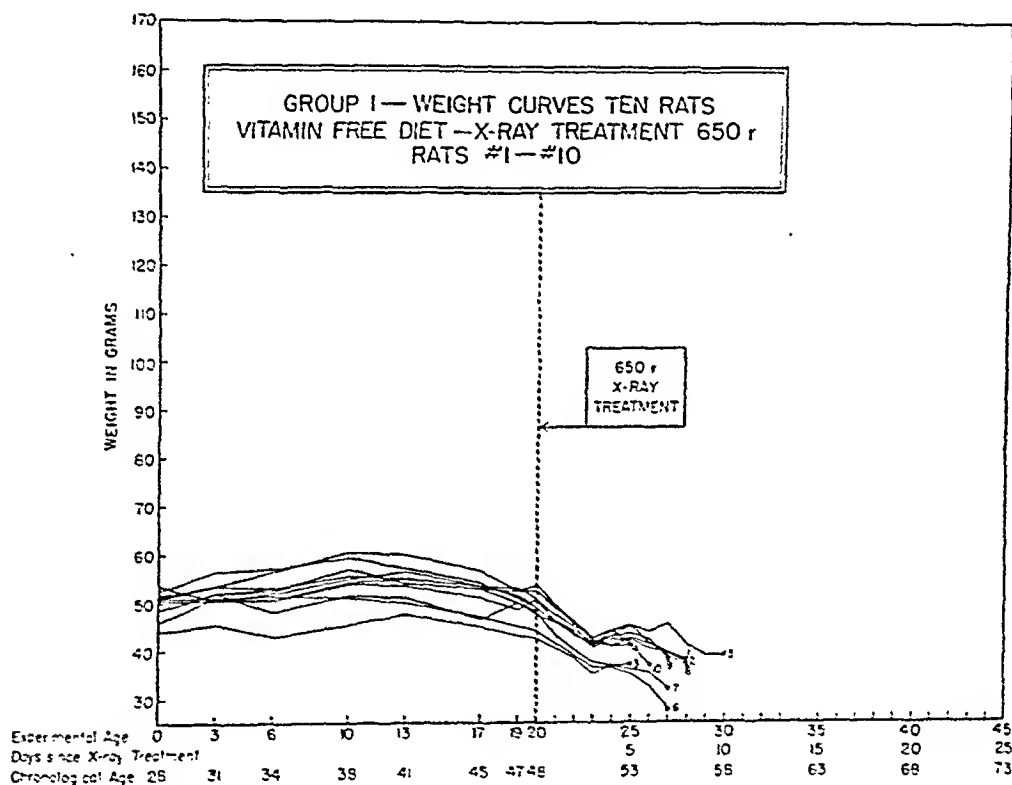


FIG. 1

diet weighed about twice as much as the deficient rats at the time of roentgen irradiation. It therefore seemed possible that the smaller rats received a greater and more penetrating dose of roentgen rays than did the larger rats. This then could partly account for the greatly increased number of fatalities in those groups. In the later experiments the amount of stock diet was limited to 5 gm. daily as in Experiments XIX and XX. With these controlled diets, all the rats were approximately the same size at the time of roentgen irradiation

so that there can be no question of the fact that the dosage received by the rats of all the groups was the same. Since the results of all these experiments are corroborative, Experiment XI may still be considered significant in spite of the difference in size of the rats in different groups at the time of roentgen irradiation.

The weight curves of the rats in Experiment XI (Fig. 1-6) clearly show the usual pattern of weight changes following roentgen-ray exposure. Immediately after the roentgen irradiation, there is a primary

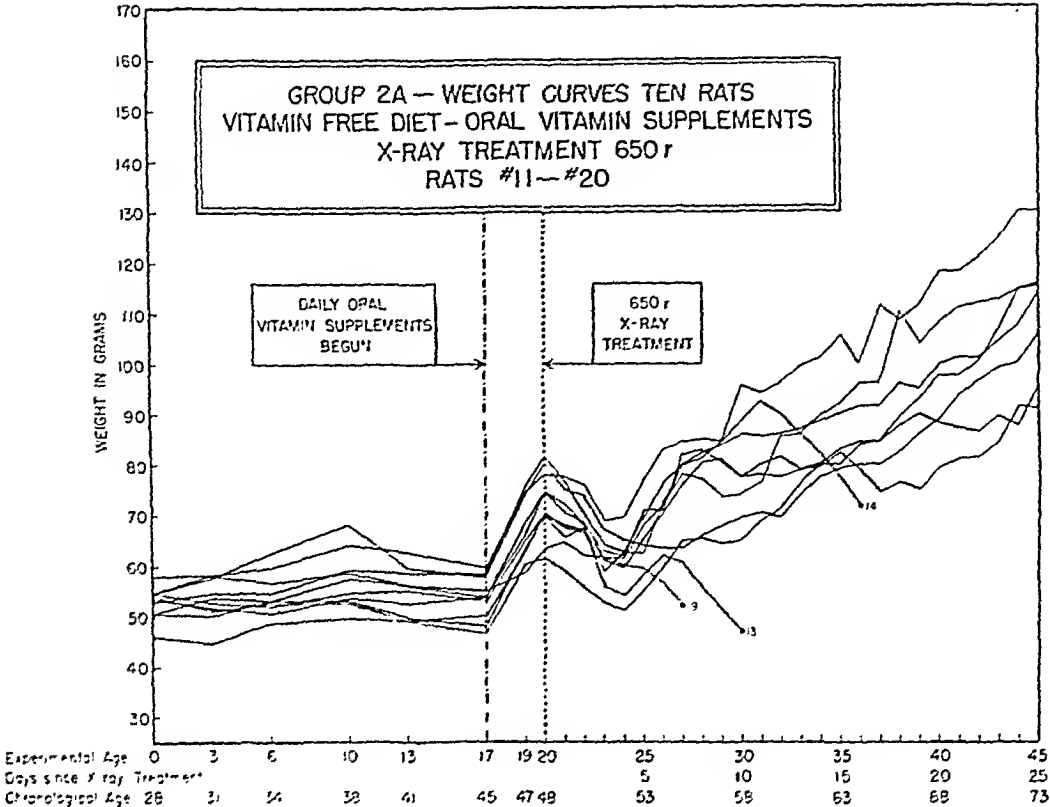


FIG. 2

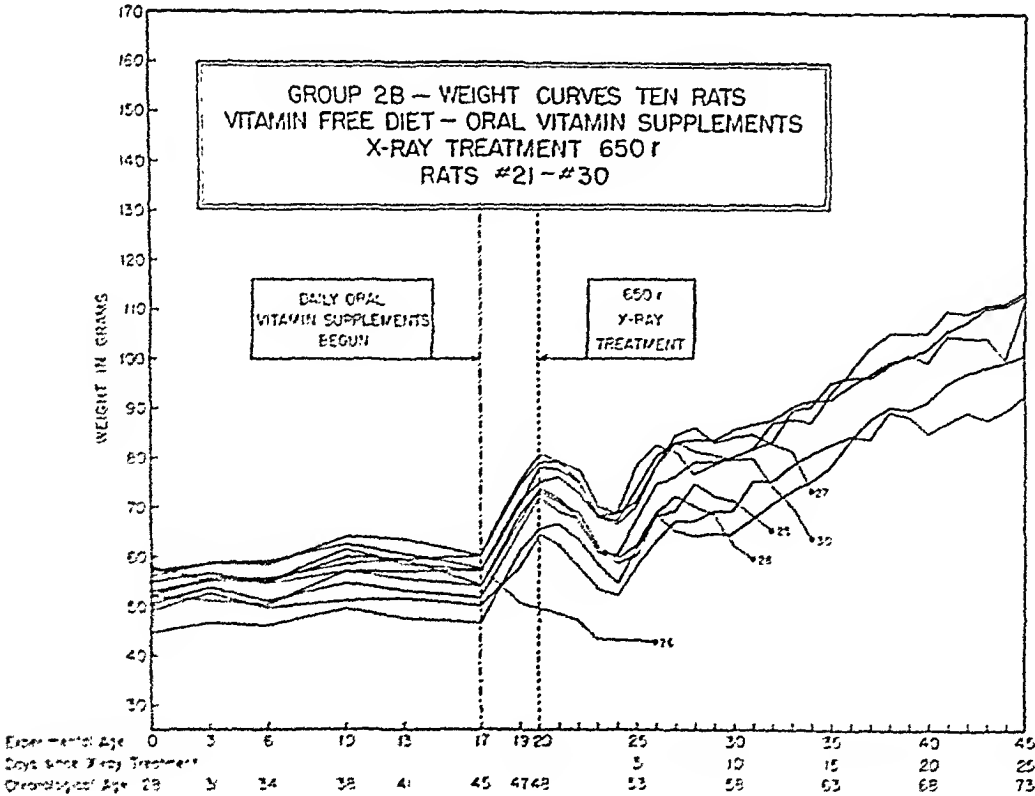


FIG. 3

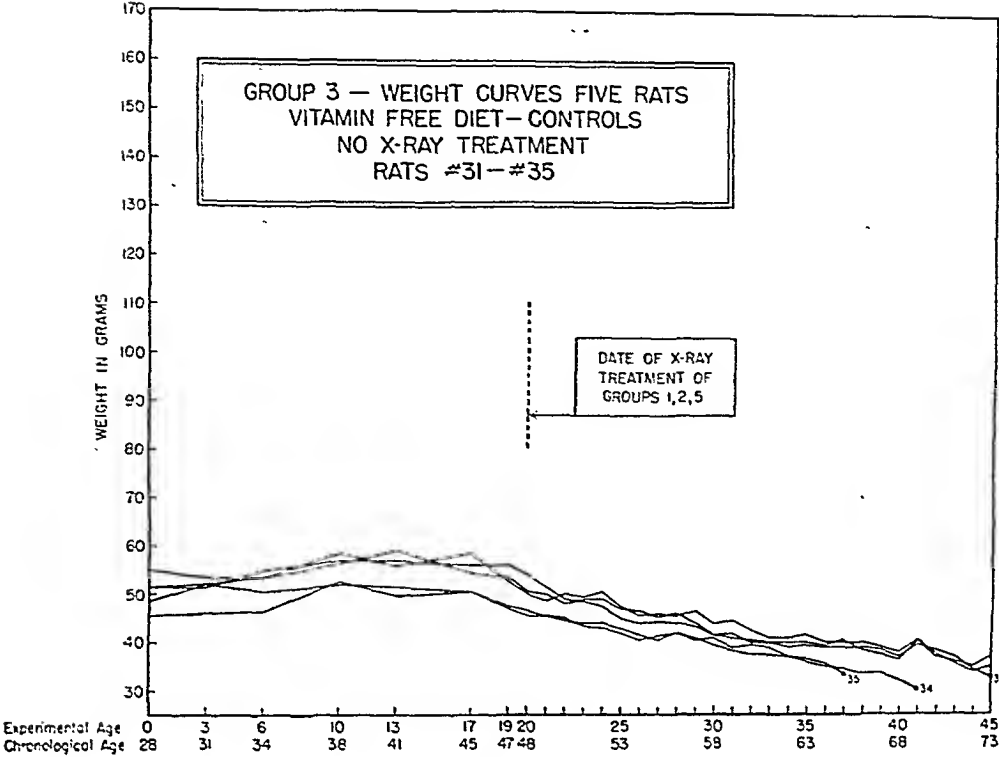


FIG. 4

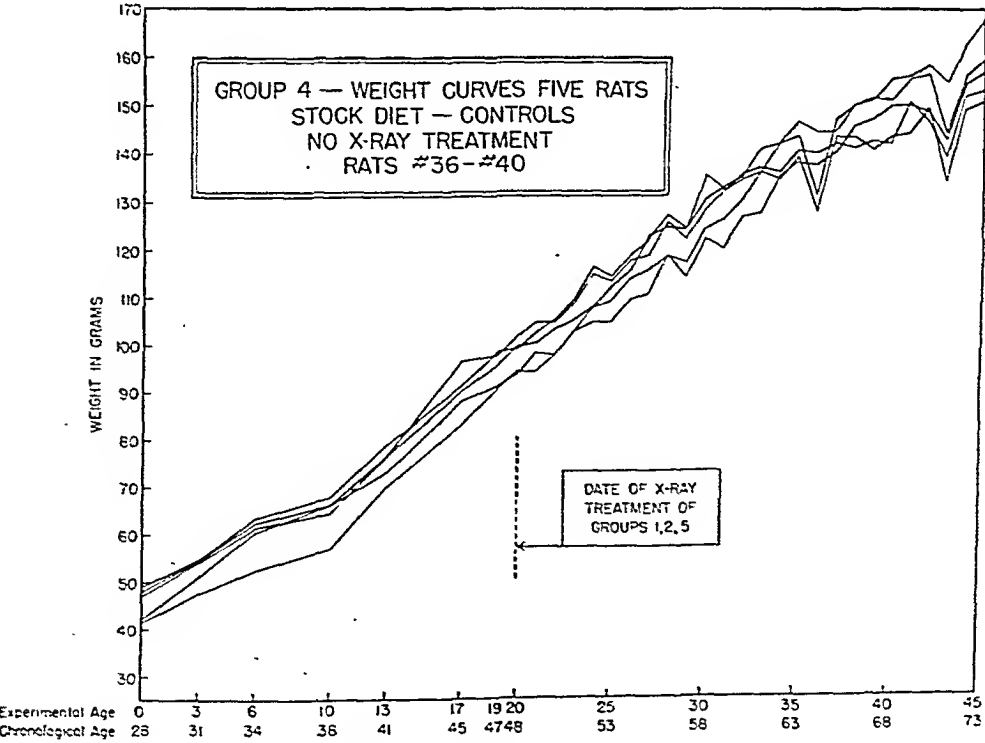


FIG. 5

weight-loss period of three to five days' duration, which may be terminated by death. This rapid weight loss is probably caused by a change in water metabolism. Subsequently the rats experience a period of weight gain which may last only a few days or which may continue indefinitely in

pallor is always followed by death. All these facts can be used as criteria for the severity of the irradiation sickness in the rats.

It should be noted in Figure 4 and in Table I that many of the rats in the control groups maintained on the vitamin-free diets in Experiment XI and in Experiments

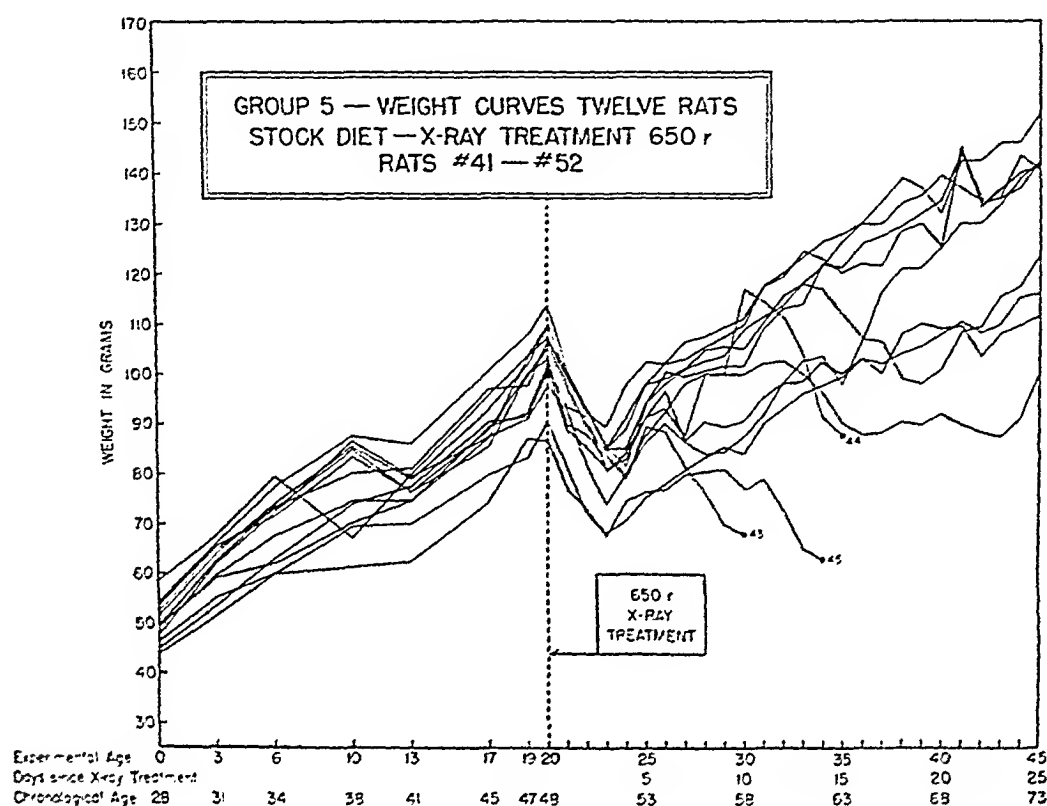


FIG. 6

the cases of the rats which fully survive the roentgen exposure. Some rats, however, then begin a second weight-loss period of varying length. If this occurs it is usually followed by death. Irregularities in growth curves may be caused by a temporary lack of water through experimental error.

Several general observations can be made of the rats after roentgen irradiation. The rats are noticeably less active, at least until the start of the weight gain period. The food consumption is markedly diminished. The fur becomes considerably loosened though it is not actually shed. There is often evidence of diarrhea. The rats may assume an extremely pale appearance so that the ears, eyes, feet, and tail become almost colorless. This severe

xix and xx also died, though they had not been exposed to roentgen radiation. This indicates the severity of the deficiencies which are produced by these vitamin-free diets. This factor must be recognized in the consideration of the fatalities following roentgen-ray exposure.

SUMMARY AND CONCLUSIONS

Criteria for the incidence and severity of irradiation sickness in rats following exposure to a single massive dose of radiotherapy were percentage fatality, weight changes, observations on activity and food consumption, and autopsy findings. The roentgen-ray dosage was determined to give approximately 50 per cent fatality under each set of experimental conditions.

These findings establish the fact that young rats on a vitamin-free diet showed marked increased susceptibility to fatal irradiation sickness when compared with rats maintained on an adequate diet. It is of considerable importance that we were able to demonstrate that the daily oral vitamin supplements of thiamine, pyridoxine, inositol, riboflavin, nicotinamide, calcium pantothenate and choline hydrochloride, begun three days before the roentgen-ray exposure, greatly decreased the incidence of fatal irradiation sickness in rats otherwise

maintained on a vitamin-free diet. These observations on 824 rats under controlled conditions support our clinical observations in this Nutrition Clinic that persons with nutritive failure have increased susceptibility to irradiation sickness. Until the basic mechanisms of irradiation sickness are fully understood, treatment for its prevention and alleviation will necessarily remain on a nonspecific and symptomatic basis.

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BY JACOB A. L. LEECH

NEURAL SURGEON, ARMY OF THE UNITED STATES

Spinal lesions in the course of military diagnosis management are an important but seldom under present conditions through the possibility of such lesions must always be borne in mind and special efforts are made to be prevented here appears to be an unusually extensive lesion of the anterior or posterior region.

A patient, Major, aged twenty-nine, reported to a General and Patient on January 5, 1945.



Fig. 1. Left side showing the lesion showing the characteristic signs of "discrete syndrome" (dorsal and lateral paraspinal) in the lumbar region.

Because of physical symptoms, particularly the pain, the patient was sent to an American hospital and placed in a general hospital where the lesions were removed under local anesthesia on January 11, 1945. In the hospital of pain in the lower back and left paraspinal region the left paraspinal and lateral paraspinal of the lumbar spine were made on January 11, 1945. The symptoms, however, were not relieved. The patient was then transferred to a general hospital, Chicago, and on

February 10, 1945, the lumbar spine was again re-examined. The two final stages were in Chicago and was followed in the general hospital on February 15, 1945. The patient was in the same type of pain. The management had other than the first in the hospital. On March 1, 1945, the management and the final stage of the lumbar spine were made two operations being made in each position.

On March 15, 1945, the two final stages were made in a general hospital. The patient was in the same type of pain. The management had other than the first in the hospital. On March 15, 1945, the management and the final stage of the lumbar spine were made two operations being made in each position. The patient was in the same type of pain. The management had other than the first in the hospital. On March 15, 1945, the management and the final stage of the lumbar spine were made two operations being made in each position.

In order to determine conclusively the nature of the "discrete syndrome" was produced by physical trauma in April 11, 1945, he was given a single exposure of the right and left paraspinal region. The patient was in the same type of pain. The management had other than the first in the hospital. On April 11, 1945, the management and the final stage of the lumbar spine were made two operations being made in each position. The patient was in the same type of pain. The management had other than the first in the hospital. On April 11, 1945, the management and the final stage of the lumbar spine were made two operations being made in each position.

* In order to determine conclusively the nature of the "discrete syndrome" was produced by physical trauma in April 11, 1945, he was given a single exposure of the right and left paraspinal region.

definitely in intensity but was still quite distinct on May 6, 1945, two months after the exposure. The two overlapping zones on the right had faded appreciably and were losing their identity by May 6, 1945, a period of fifteen and seven weeks respectively after the exposure. The zone in the suprapubic region had also faded somewhat. By May 18, 1945, the fading had progressed definitely but slightly.

The original exposures were made with a 200 ma. Philips tube, oil immersed with an inherent filtration equivalent to at least 0.5 mm. Al but no added filtration.* The trial exposure to the right lateral thigh was made with a 100 ma. single focus, oil immersed Machlett tube, Aeromax "12," with an inherent filtration not over 0.5 mm. aluminum. It is not known what factors or types of equipment were used at the previous hospitals. With the same factors employed in making the trial exposure to the right thigh namely twelve seconds, 30 ma., 85 kv., at 19 inch tube-target distance with the same type of tube, Machlett Aeromax "12" (with a Westinghouse machine in place of the Philips originally used), it was found that 32 roentgens were delivered in air. The measurements were made with the Victoreen ionization chamber in Lieutenant Colonel Rude's laboratory. Subsequently in this department with a Philips 200 ma. tube and the Philips machine with the same factors mentioned above, it was determined that 23 roentgens were delivered in air. No sphere gap was available to check the voltages at the time of these two measurements but it is evident that different outputs are to be expected considering that different tubes, different types of transformers as well as slightly different line voltages were utilized. Still the anteroposterior views were made at approximately 24 inch tube-target distance, the exposure factors being 70 kv., four seconds at 30 ma., which even when multiplied by two would still be considerably less than that employed in the trial exposure.

It should be considered that the technique employed on this patient has been used many times on others apparently



FIG. 2. Right side (nearest the camera) showing zone of "chocolate erythema" ten days after trial exposure.

without untoward results. In fact, the customary procedure in studies of the lumbar and sacral spine has been to take anteroposterior and lateral views of the entire region and spot anteroposterior and lateral views of the lumbosacral region. In addition, oblique views have been made when indicated (occasionally stereoscopic). Since most of our patients were white, any erythema would have been noted very readily. To sum up all these factors, it seems evident this patient was unduly sensitive to roentgen rays.

Fortunately, such sensitivity happens but rarely but since it does occur it serves to emphasize the importance of ascertaining what exposures have been made and the advisability of using additional filters. The importance to the patient of knowing this fact is obvious, and he has been cautioned to inform his physician regarding his sensitivity should he ever require further roentgen examination or more particularly roentgen treatment.

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* 1 mm. Al filter has since been secured for this tube.



A VISIT TO RÖNTGEN'S LABORATORY IN 1923

By PAUL C. HODGES, M.D.

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CHICAGO, ILLINOIS

COLONEL Etter's account* of his 1945 visit to the Physical Institute in war-ruined Würzburg recalls to my mind a visit that I made in the Spring of 1923, reported orally at the 1923 meeting of the American Roentgen Ray Society but until now have not published.

It was a rainy day in May, 1923, when I

tute. At that time I was a member of the faculty of the Peking Union Medical College and since my sabbatical year was financed in part by a fellowship from the Rockefeller Foundation I carried letters of introduction from some of the officers of that organization. Those letters opened von Frey's door for me despite the fact that he had to be called away from a class, but it



FIG. 1. Photograph of Röntgen at the age of sixty-three. Purchased from a professional photographer in Munich and presented to me in China by my friend, Dr. Adrian Taylor.

called at the University of Würzburg and presented my credentials to Professor von Frey, the head of the Physiological Insti-



FIG. 2. Physical Institute as it appeared in 1923. The plaque which was attached to the building in 1905 freely translated reads: "In this building, in the year 1895, W. C. Röntgen discovered the rays that have been named for him." Colonel Etter's 1945 Figure 1A seems to be taken from about the same point. If this assumption is correct, then the years have seen several changes. The iron railing and vines have been removed. The corner window has been walled up and the old plaque has been replaced by lettering on the new masonry at the former window site.

* Etter, L. E. Post-war visit to Röntgen's laboratory. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 54, 547-552.

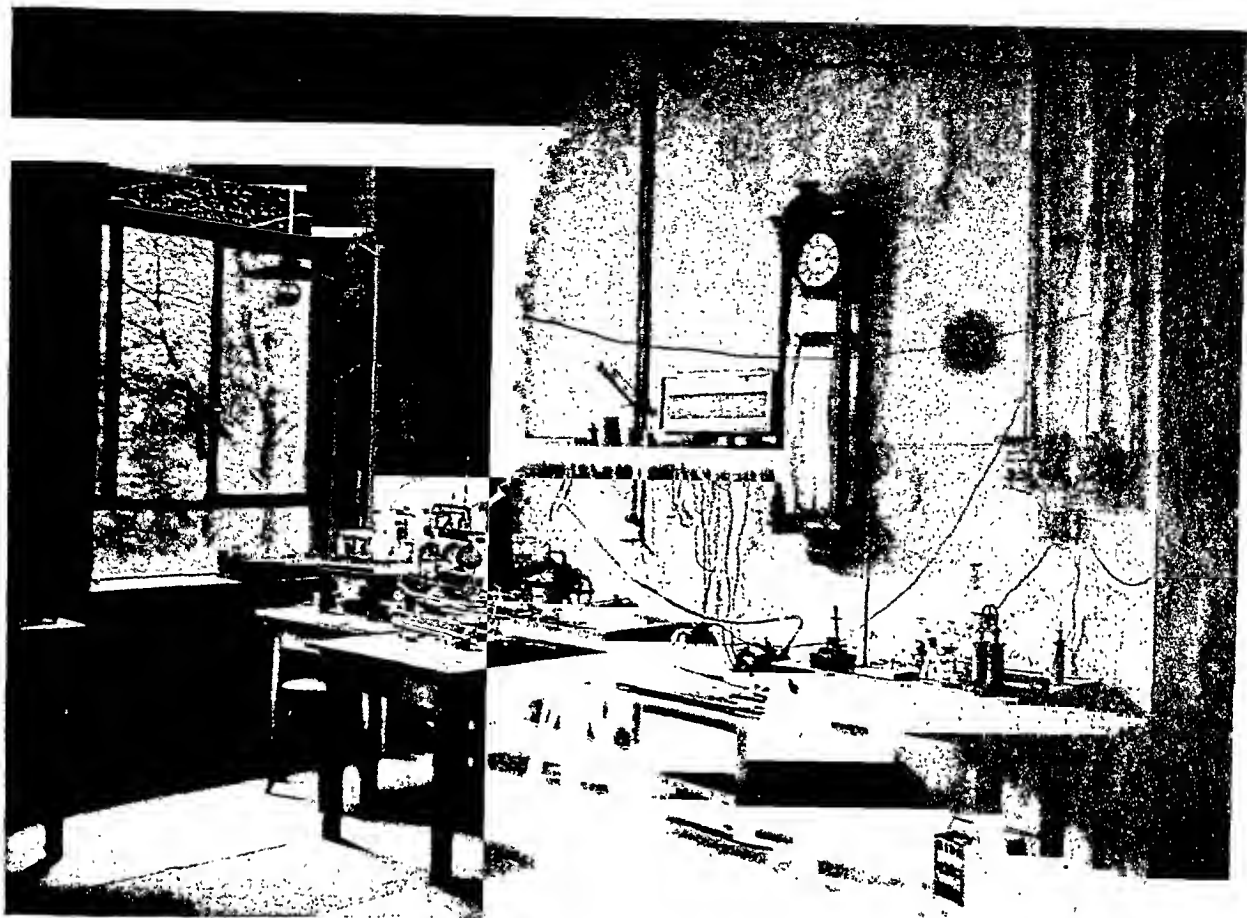


FIG. 3. Laboratory room in which Röntgen discovered the x-ray. By 1923 when this photograph was made, electrical conduits, outlets and motors had been added but the clock, stools and benches were used by Röntgen. At the extreme right of this photograph is the edge of the door that is pictured in Figure 4.

was my other letters from my former teachers and his old friends in the Department of Physiology at the University of Wisconsin that opened his heart and caused him to turn over his class to an assistant so that he might devote the rest of the day to me.

It was my purpose, I told von Frey, to see for myself the laboratories in which Röntgen discovered the x-ray. He escorted me to the nearby Physical Institute and introduced me to the current director, Professor Wagner, but the reception was far from cordial. Röntgen had been gone from Würzburg for twenty-three years and in the few weeks since his death his old institute had not had time to get used to the idea that now he belonged to them again rather than to Munich where the closing years of his life had been spent. Middle-class Germans and particularly university people

had more pressing problems than Röntgen museums and sentimental journeys by Americans because an explosive inflation of the currency was ruining them. This inflation was generally attributed to the disastrous outcome of World War I and, by implication, to Americans, whose armies had had so much to do with that outcome. Even with my imperfect knowledge of German, I understood enough fragments of the conversation to realize that von Frey was having no easy time penetrating Wagner's reticence and disarming his conviction that this visiting American was a nuisance and probably had better be shown the door. He persevered, however, and gradually under his persistent urging and his unfailing smile, Wagner's suspicious reserve melted into helpfulness that at times became almost cordial.

At that time there were sharp restrictions

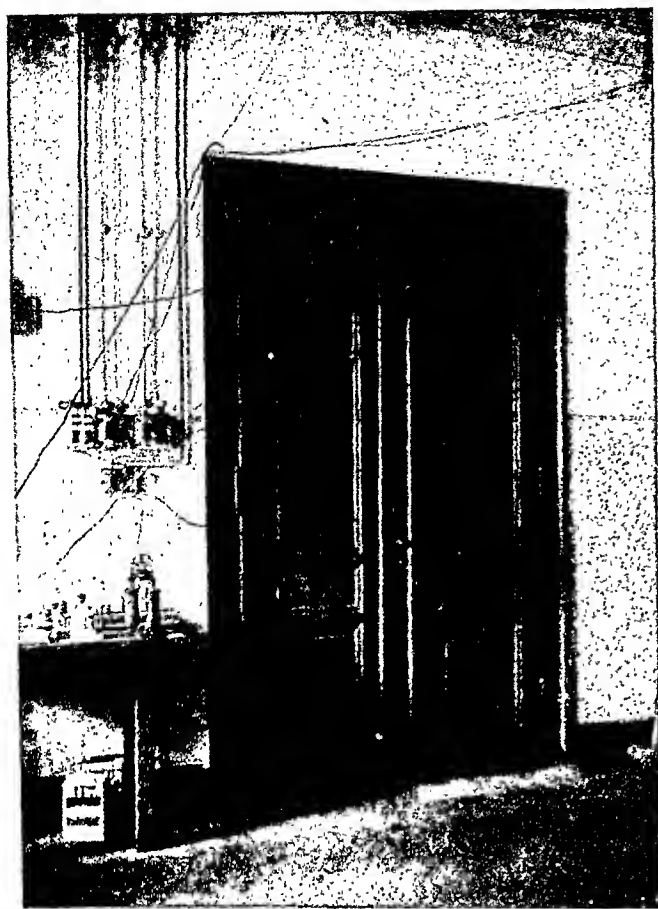


FIG. 4. Door through which Röntgen passed x-rays. It is said that Röntgen dismantled this door to determine why plates taken through it showed certain bands of decreased density. He demonstrated that these bands were shadows cast by white lead that had been used as a filler between panels and mouldings.

on the carrying of currency, cameras, binoculars, and so forth, across the Swiss-German border; and to avoid trouble I had brought in no camera. Instead it was my plan to employ a commercial photographer to make photographs of the laboratory if the authorities were willing. Wagner was agreeable to this and so off through the rain we went, von Frey and I, in a hired carriage to the photographer's shop. The photographer, we found, would be glad to oblige but he pointed out that this dark rainy day was far from ideal for indoor photography. Would it not be better, he said, to plan for the work today but actually do it later and then send the plates to me? This seemed reasonable, and so the three of us went back to the laboratory to decide with Wagner as to just what should be photographed.

There was to be one plate, of course, of the outside of the building to show the dedicatory plaque that had been attached to it in 1905 (Fig. 2); a second of the laboratory room in which the discovery had been made (Fig. 3); a third of the door through which Röntgen had passed a beam of x-rays (Fig. 4); a fourth of Röntgen's desk bearing his parents' photographs and his Nobel Prize (Fig. 5); and a fifth of some of the tubes, screens and targets that had figured in the discovery (Fig. 6). These arrangements being completed, I thanked Wagner for the privilege of visiting his laboratory and having it photographed and with von Frey took the photographer back to his shop where I paid him in United States dollars for the work that he had



FIG. 5. Desk and chair of Professor Röntgen. At the time of my visit in 1923, this desk was in a dusty storeroom in which there had begun to collect the material that in time would stock a museum. In the interval between my visit and the photographer's return the room was cleaned and its contents arranged for public exhibition. On the top shelf of the desk are photographs of Röntgen's parents and lying among the papers on the desk is his Nobel Prize certificate.

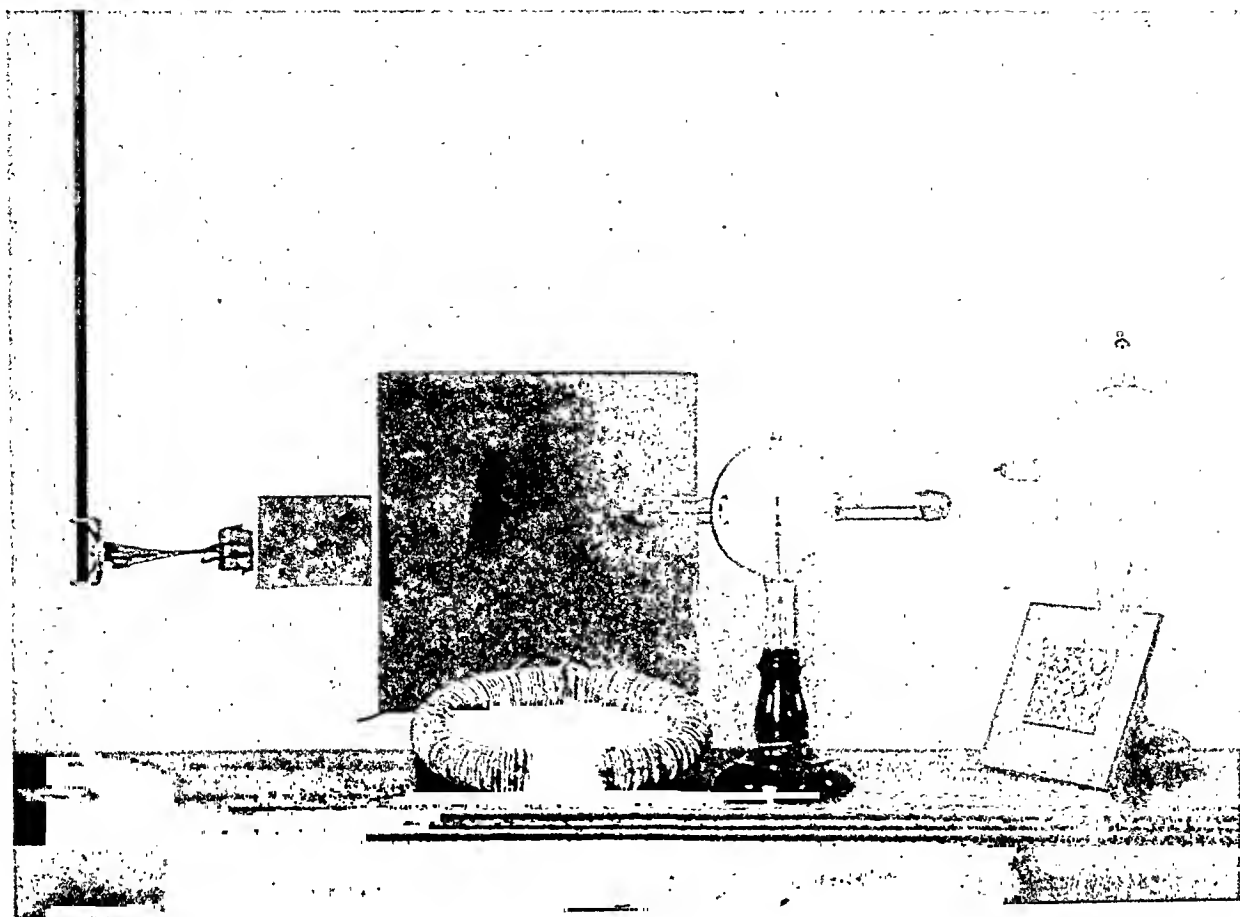


FIG. 6. Tubes, targets, screens and electromagnets used by Röntgen in connection with his discovery. Colonel Etter's Figures 3A, 3B and 3C show that by 1945 much material had been added to the museum.

agreed to do on the first bright day. I had privately discussed with von Frey the propriety of my doing something for Wagner's laboratory in return for the courtesy shown me and he had suggested that the gift of a set of the photographer's prints no doubt would be acceptable. The inflation had rendered university budgets so nearly valueless that even such a modest expenditure as this could scarcely be afforded by the Institute. My payment to the photographer included a set of prints that he was to hand to Professor Wagner.

Several weeks later there arrived at my lodgings in Zurich, Switzerland, a set of prints and a letter from the photographer but no plates. The plates, he explained, could not be sent after all because of some real or imagined government regulation. The second set of prints had been turned over to Professor Wagner and please would

I send the photographer another five dollars because his expenses had been greater than he had estimated.

In July, 1923, I returned to the United States and on visiting Hollis Potter in Chicago was invited by him to report at the September meeting of the American Roentgen Ray Society on roentgenology in China and on my trip to Röntgen's laboratory. It was too late to be included in the regular program but he could put me on as one of the after-dinner speakers at the dinner dance September 23. Mr. Silas W. Nourse, a professional photographer from Palisade, New Jersey, made lantern slides for me from my Würzburg prints and was present on the evening when I showed them, having come to Chicago to assist the late Mr. Paul B. Hoeber arrange the scientific exhibit. Since I was not on the regular program, it was not required that I submit a manu-

script for publication, and being busy with other matters at the time I was glad to escape the chore. Accordingly when several friends asked where the photographs were to be reproduced and when, I explained that I was not publishing them but had authorized Mr. Nourse to make copies for anyone who wanted them.

In the years since my return to the United States in 1927 I have on occasion loaned the original prints to friends who were writing books on Röntgen and have

presented sets of slides to others who are teachers of roentgenology. Recently I have seen reproductions of my photographs credited to this or that source, sometimes even with a copyright claim; and a current advertisement of one of the film manufacturers uses one of them but credits it to a Cleveland collection.

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EDITORIALS

ANOMALIES OF THE AORTIC ARCH AND GREAT VESSELS

FOR more than two hundred years there have appeared in the medical literature reports of aberrations in the development of the arch of the aorta or of arteries leading from it, and of congenital heart lesions, but it was not until the epoch-making work of Maude Abbott that the subject became of such general and widespread interest that, as Paul White says, "we no longer regard it with either disdain or awe as a mystery for the autopsy table alone to discover and to solve. She has been . . . most important . . . in establishing congenital heart disease as a living part of clinical medicine."

Maude Abbott's¹ splendid "Atlas of Congenital Cardiac Disease" was published in 1936 but we have travelled a long way since that date not so much in the basic anatomical knowledge which she so clearly elaborated but in the surgical approach to the cure or relief of some of these anomalies, particularly those of the aortic arch and its branches.

This surgical approach to the alleviation of certain of these anomalies which bring about symptoms has been made possible by the roentgenologist who has provided techniques for recognition of many of these malformations in the living subject.

Quite recently Neuhauser² has called attention to the importance of the roentgen diagnosis of double aortic arch and other anomalies of the great vessels. The recognition of these anomalies and their demonstration by the roentgen ray is of great importance because with the perfection of

surgical technique and the mastery of the problems of preoperative and postoperative care, most of these anomalies, particularly those that are disabling or fatal in their effects, are now amenable to cure or improvement.

In Neuhauser's important paper is given a workable classification of the anomalies that involve the aorta and the vessels which stem from it. He points out that a knowledge of the embryological development of the aortic arch is essential for a complete understanding of the pathogenesis of these anomalies, but in his paper he has presented only a minimum of anomalies and he has limited his discussion to the roentgen diagnosis, emphasizing the fact that in many of these anomalous conditions the diagnosis can be made only by means of an adequate roentgenological study. He sets forth the various anomalies which are productive of symptoms and describes the detailed roentgenological examinations that are necessary to bring about a recognition of these anomalies, calling particular attention not only to the roentgenoscopic but to the roentgenographic methods of study, and above all, to the importance of outlining the esophagus with barium in order to definitely establish its relation to the aortic arch and its anomalies that might be productive of symptoms.

While some of these anomalies of development of the aortic arch may produce few or no symptoms and are frequently of only academic interest, Gross and Ware,³ as well as Neuhauser and others, have pointed out a variety of complaints that may come from these regional malforma-

¹ Abbott, Maude E. *Atlas of Congenital Cardiac Disease*. American Heart Association, New York, 1936.

² Neuhauser, E. B. D. Roentgen diagnosis of double aortic arch and other anomalies of the great vessels. *AM. J. ROENTGENOL. & RAD. THERAPY*, July, 1946, 56, 1-12.

³ Gross, R. E., and Ware, P. F. Surgical significance of aortic arch anomalies. *Surg., Gynec. & Obst.*, October, 1946, 83, 435-448.

tions. Associated with these anomalies may be dysphagia, stridor, dyspnea, cyanosis, hoarseness, cough, pain in the upper chest and vague sensations in the arms, and in addition they may impose an extra burden on the heart because of an arteriovenous type of shunt or may lead to severe derangements in the circulation because of an obstruction in the aortic pathway. Infants and children presenting such symptoms should have careful roentgenological studies, keeping in mind the possibility of the anomalies of development of the aortic arch as a possible causative factor.

The brilliant chapter that is being written in the surgical treatment of anomalies of the aortic arch and its vessels imposes

an added responsibility upon the roentgenologist in the recognition of these anomalies. Since the only possible means by which a certain diagnosis can be established is by careful roentgenological studies, it is incumbent upon the roentgenologist to fortify himself with the knowledge of the types and varieties of anomalies that may be expected and of the careful roentgenological observations and techniques which are needed in order to arrive at a proper diagnosis in these conditions which have until within recent years been considered of only academic interest but are now of vital interest because of the possibility of surgical cure.



*J. Anthony Bill*

ELLIS ROBERT BADER
1888-1946

DR. ELLIS ROBERT BADER, of Cincinnati, Ohio, died of chronic myelogenous leukemia on June 16, 1946, at the age of fifty-eight. Dr. Bader was born in Hamilton, Ohio, and obtained his early education there. He attended the University of Cincinnati College of Medicine

from which he graduated in 1913.

During World War I, Dr. Bader served first as a medical officer in the British Army and later transferred to the United States Army. In 1919 he became associated in the private practice of radiology with Dr. William Doughty which continued

until the latter's death in 1944. He is survived by his wife, Dorothy Adams Bader, a daughter, Harriet Bader Wilks who is a registered nurse, and a son, Robert who is a medical student.

During his professional career, Dr. Bader was Radiologist at Bethesda and Deaconess Hospitals in Cincinnati, and at the time of his death, was Radiologist at Christ Hospital. He was also on the staff at the Children's Hospital. In 1940 and 1941, he was President of the staff at the Deaconess Hospital. In previous years, he had been Radiologist at St. Elizabeth's Hospital in Covington, Kentucky, and also served the Veterans' Administration as Radiologist. He had been Secretary of the Cincinnati Academy of Medicine and, from time to time, was a member of some of its committees. He was also a member of several important committees of the Ohio State Medical Association. In 1937, he was First Vice-President of the Radiological Society of North America and, prior to that, had been Counselor for Southern Ohio for many years. At the time of his death, he was Councilor for Southern Ohio of the American College of Radiology and was the Second Vice-President of the American

Roentgen Ray Society. At the time of his death, he was also President of the Radiological Section of the Cincinnati Academy of Medicine. For many years, he had been Assistant Professor of Radiology at the Cincinnati College of Medicine. He was also a member of the Cincinnati Academy of Medicine, the Ohio State Medical Association and the American Medical Association.

To those who knew Dr. Bader, certainty of purpose characterized his life. He was unswervingly devoted to his home and family and after that came his professional career which he followed with fixed and definite purpose. He had an unusually wide circle of friends and acquaintances in the Cincinnati area and he was well known in national radiological circles. He was known for his honesty and integrity and had built an enviable reputation as a radiologist. In his life, he reflected only credit on the practice of medicine in general and on the specialty of radiology in particular. The American Roentgen Ray Society has lost a valuable member and his associates a devoted friend.

HAROLD G. REINEKE



EUGENE ROLLIN CORSON 1856-1946

DR. EUGENE ROLLIN CORSON died in Savannah, Georgia, on June 10, 1946, at the age of ninety. He was born in Washington, D. C., July 20, 1856. Dr. Corson was a life member of the American Roentgen Ray Society and was an honor guest at one of its annual meetings. He was also honored by invitations to present papers before learned societies in this country and abroad, and also by the Georgia Medical Society, which tendered him a testimonial dinner and meeting.

The usual obituary would be largely a repetition of a fine article entitled "A Pioneer Roentgenologist" written by Dr. E. H. Skinner and published in the *AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY*, 1931, Vol. 26, pp. 759-764. It is urged that this splendid tribute to Dr. Corson by Dr. Skinner be read. It well describes his life and works, and gives a bibliography of his writings.

He was a man of many interests. He read and discussed with equal fervor not only the different branches of medicine but also the allied studies of philosophy and spiritualism. He was interested in public education, especially that pertaining to the Negro, and he studied the Negro as a race. Even when his roentgenological contributions were receiving national and international acclaim, he could not be persuaded to limit his efforts to radiology. In his dramatic way he proclaimed himself a

physician and surgeon and continued to follow the many calls and duties of a general practitioner. It was a sad day in his life when the radiation injury to his hand necessitated his giving up surgery and obstetrics. He was happiest when treating the humble and destitute. He was a poor business man; his income suffered. He had in his office a plaster statue of "The Charity Patient." One of my early remembrances of him was the reverent way he pointed to it and gave me some understanding of our obligations to the poor. He was artistic and temperamental and had a kind and sympathetic nature. The sufferings and hardships of others affected him, and made him an easy prey to the narcotic habits.

It is my firm belief that had he lived in a teaching center and limited his endeavors to radiology, the stimulus of his associates and the richer clinical material would have fired his imagination to more fruitful accomplishments.

His last days were not happy. His mind was active, but his body weak. The malignant changes which followed the exposure he experienced when studying his own wrist were the cause of his death. This treatise, "The Normal Movements of the Carpal Bones and Wrists," was published in 1898.

He leaves his wife, two daughters, and a son whose grief we share.

ROBERT DRANE



SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY

Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: 1947, to be announced.

AMERICAN COLLEGE OF RADIOLOGY

Secretary, Mac F. Cahal, 25 N. Wacker Drive, Chicago 6. Annual meeting: 1947, to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: 1947, to be announced.

AMERICAN RADIUM SOCIETY

Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: 1947, to be announced.

ALABAMA RADIOLOGICAL SOCIETY

Secretary, Dr. John D. Peake, Mobile Infirmary, Mobile Ala. Next meeting time and place of Alabama State Medical Association.

ARKANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Palmer House, Chicago, Ill., Dec. 1-6, 1946.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

Secretary, Dr. Max Climian, 242 Trumbull St., Hartford, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary. Annual meeting in May.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY

Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill.

RADIOLOGICAL SECTION, LOS ANGELES CO. MED. ASSN.

Secretary, Dr. Roy W. Johnson, 1407 S. Hope St., Los Angeles, Calif. Meets on second Wednesday of each month at the County Society Building.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION

Secretary, Dr. Roy G. Giles, Temple, Texas.

BROOKLYN ROENTGEN RAY SOCIETY

Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph S. Gian-Francheschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months.

CHICAGO ROENTGEN SOCIETY

Secretary, Dr. T. J. Wachowski, 310 Ellis Ave., Wheaton, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY

Secretary, Dr. Samuel Brown, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY

Secretary, Dr. Carroll C. Dundon, 11311 Shaker Blvd.,

Cleveland, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB

Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DENVER RADIOLOGICAL CLUB

Secretary, Dr. W. C. Huyler, 1619 Milwaukee, Denver 6, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Dell, Jr., 333 W. Main St., S., Gainesville, Fla. Meetings in May and November.

GEORGIA RADIOLOGICAL SOCIETY

Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

RADIOLOGICAL SOCIETY OF KANSAS CITY

Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

IOWA X-RAY CLUB

Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KENTUCKY RADIOLOGICAL SOCIETY

Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY

Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

LOUISIANA RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association, the other in the fall.

NEBRASKA RADIOLOGICAL SOCIETY

Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Neb. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library

NEW HAMPSHIRE ROENTGEN RAY SOCIETY

Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

RADIOLOGICAL SOCIETY OF NEW JERSEY

Secretary, Dr. W. H. Seward, Orange Memorial Hospital, Orange, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY

Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY

Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

CENTRAL NEW YORK ROENTGEN RA SOCIETY

Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

OHIO RADIOLOGICAL SOCIETY

Secretary, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

ORLEANS PARISH RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC ROENTGEN SOCIETY

Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. C. L. Stewart, Jefferson Hospital. Meets first Thursday of each month, October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY

Secretary, Dr. L. M. J. Freedman, 115 South Highland Ave. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

PORTLAND ROENTGEN CLUB

Secretary, Dr. Selma Hyman, University of Oregon Medical School, Portland, Oregon. Meets monthly 2d Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Secretary Dr. A. M. Popma, 220 N. First St., Boise, Idaho.

ST. LOUIS SOCIETY OF RADIOLOGISTS

Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY

Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

SAN FRANCISCO RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph Levitin, 516 Sutter St., San Francisco 2, Calif. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

SHREVEPORT RADIOLOGICAL CLUB

Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00-5:00 P.M., Room 301, Service Memorial Institute.

UTAH RADIOLOGICAL CONFERENCE

Secretary, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 P.M., Salt Lake County General Hospital, September to June.

UTAH STATE RADIOLOGICAL SOCIETY

Secretary, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

VIRGINIA RADIOLOGICAL SOCIETY

Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO

Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA

General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE ROENTGEN SOCIETY

Medical Members' meeting held monthly on third Friday at 2:30 P.M. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

FACULTY OF RADIOLOGISTS

Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.

CANADIAN ASSOCIATION OF RADIOLOGISTS

Secretary, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, P. Q.

SOCIÉTÉ CANADIENNE-FRANCAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES

Secretary, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION

Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

SOUTH AMERICA

SOCIEDAD ARGENTINA DE RADIOLOGIA

Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

SOCIEDAD PERUANA DE RADIOLOGIA

Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

CONTINENTAL EUROPE

CESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE

Secretary: MUDr. Roman Blána, Praha XII, Ko-runni 160, Czechoslovakia.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA

Secretary, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)

Secretary for French language, Dr. Babaianz, Geneva. *Secretary* for German language, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE

Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.

Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY

Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY

Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES

The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

CANCER TEACHING DAY

A Cancer Teaching Day was held at the Hermann M. Biggs Memorial Hospital, Ithaca, New York, on October 10, 1946. The meeting was called to order at 4:00 P.M. by the Chairman, Dr. N. Stanley Lincoln, Superintendent of the Hermann M. Biggs Memorial Hospital. The opening

remarks were made by Dr. Louis C. Kress, Director of the Roswell Park Memorial Institute. Two papers were given: "Cancer of the Lung" by Dr. Richmond Douglass, Senior Tuberculosis Hospital Physician, Hermann M. Biggs Memorial Hospital, and "Cancer of the Esophagus" by Dr. John H. Garlock, Attending Surgeon, Mt. Sinai Hospital, New York. The Chairman of the evening meeting was Dr. Robert H. Broad, President of the Medical Society of the County of Tompkins. The following two papers were presented: "Cancer of the Cervix" by Dr. Gray H. Twombly, Co-director, Gynecological Service, Memorial Hospital, New York, and "Cancer of the Breast" by Cushman D. Haagensen, Assistant Professor of Surgery, College of Physicians and Surgeons, New York.

ALABAMA RADIOLOGICAL SOCIETY

At the April meeting of the Alabama Medical Association, a group of radiologists met and organized the Alabama Radiological Society. The next meeting will be at the same time and place as the Alabama State Medical Association. The officers are as follows: *President*, J. A. Meadows, M.D., Birmingham; *Vice-President*, Courtney S. Stickley, M.D., Montgomery; *Secretary-Treasurer*, John Day Peake, M.D., Mobile.

CHICAGO ROENTGEN SOCIETY

At a recent meeting of the Chicago Roentgen Society, the following officers were elected for the coming year: *President*, Earl E. Barth, M.D., Chicago, Illinois; *Vice-President*, Fay H. Squire, M.D., Chicago, Illinois; *Secretary*, T. J. Wachowski, M.D., Wheaton, Illinois.



BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

PEDIATRIC X-RAY DIAGNOSIS: A TEXTBOOK FOR STUDENTS AND PRACTITIONERS OF PEDIATRICS, SURGERY AND RADIOLOGY. By John Caffey, A.B., M.D., Associate Professor of Pediatrics, College of Physicians and Surgeons, Columbia University; Associate Pediatrician and Roentgenologist, Babies Hospital and Vanderbilt Clinic, New York City, etc. Cloth. Price, \$12.50. Pp. 838, with 711 illustrations. Chicago: The Year Book Publishers, 1945.

In 1910, Dr. Thomas M. Rotch published "The Roentgen Ray in Pediatrics." Since then no book devoted entirely to pediatric roentgen diagnosis has appeared. The publication of Caffey's volume supplies a long standing need for a reference and textbook for both radiologists and pediatricians. In remedying this need, he has written a complete treatise, based on his experience of the past twenty years. The reproductions of the roentgenograms are all taken from the files of the roentgen departments with which he is associated. In his preface, he states his purpose is twofold: description of shadows cast by normal and morbid tissues, and clinical appraisal of roentgen findings in pediatric diagnosis. In this he has been extremely successful.

The text is divided into six sections: (1) The Head and Neck; (2) The Thorax; (3) The Abdomen and Gastrointestinal Tract; (4) The Pelvis and Genito-Urinary Tract; (5) The Extremities and (6) The Vertebral Column. In each section the normal roentgen appearance is first described followed by descriptions of the various morbid processes. The sections are well covered and throughout the reader is impressed by the wide experience of the author with a resultant authoritative expression of his clinical appraisal of the roentgen findings. The illustrations of the roentgenograms are clear and drawings are freely used to illustrate anatomical findings. The bibliography is not voluminous but is nevertheless sufficient to permit further study of any subject. The style is readable and succinct. The format is excellent.

One of the salient features of the book is the emphasis upon normal roentgen anatomy.

Another is the inclusion of the most frequently occurring conditions in infants and children with omissions of those of infrequent occurrence, thus permitting more ample discussion of the former. There is little of a controversial nature in the author's opinions to which exception might be taken.

Caffey's book should be included in the library of every radiologist and as a reference book for pediatricians it cannot be excluded. For those radiologists whose pediatric patients are of limited number it is a godsend.

R. S. BROMER

ELECTRON AND NUCLEAR COUNTERS: THEORY AND USE. By Serge A. Korff, M.A., Ph.D., Associate Professor of Physics and Supervisor of Physics Research, College of Engineering, New York University. Price, \$3.00. Pp. 212, with 69 illustrations. New York: D. Van Nostrand Company, Inc., 1946.

Since its introduction almost forty years ago, the Geiger counter tube has become a powerful measuring instrument for all types of radiations. Although the most startling developments of these tubes as detector and measuring instruments have taken place during the last few years and mostly in connection with atomic energy investigation, they have been used for years in numerous other research projects. In radiology, Geiger counters have been used to detect lost radium. Subsequently, surveys of protection against roentgen rays and radium were carried out with Geiger counters, and recently the instrument has become indispensable for detecting and measuring minute traces of radioactive isotopes introduced into the organism. A wide variety of counters have been built for numerous purposes, but detailed information on their construction and use is not yet generally available.

This book is welcome since it is one of the first comprehensive reports on electron and nuclear counters. It will undoubtedly shed light on many confused and haphazard ideas about counters which have been circulated during the last few years. Tracing the historical develop-

ment of Geiger counters from the Rutherford-Geiger alpha-ray counter described in 1908 and the Geiger point counter of 1913, Korff describes in great detail the theory and operation of *proportional counters* as well as self-quenching and non-self-quenching Geiger counters. This is followed by practical suggestions regarding the preparation and construction of counters and by a critical discussion of errors and corrections made in evaluating the counts. A chapter on auxiliary electronic circuits in connection with counters concludes the valuable text material. This last chapter contains a list of articles and books on electronic circuits and on counter problems as well as references to commercial sources of supply of counters, circuits and materials for their construction. This latter list, unfortunately, is far from complete.

A general bibliography as well as an author and subject index for the book is appended. To radiologists who will become more and more involved in problems requiring the use of counter equipment, this book can be highly recommended as a textbook and guide in the construction and successful operation of Geiger counter apparatus.

OTTO GLASSER

ULTRAVIOLETTE STRAHLEN: IHRE ERZEUGUNG, MESSUNG UND ANWENDUNG IN MEDIZIN, BIOLOGIE UND TECHNIK. Von A. E. Herbert Meyer, Dr. phil., und Ernst Otto Seitz, Dr. phil. Mit einem Geleitwort von Professor Dr. B. Rajewsky, Direktor des Kaiser-Wilhelm-Institutes für Biophysik, Frankfurt a.M. Cloth. Price, \$10.00. Pp. 308, with 217 illustrations and 40 tables. Berlin: Walter de Gruyter & Co., 1942. J. W. Edwards, Publisher, Ann Arbor, Michigan.

This book has been prepared by the authors for the physician, biologist, chemist and physicist who all are using ultraviolet rays in their respective fields of endeavor. So far a survey of the entire field has been lacking and this publication is presented for the purpose of filling that gap.

In an introductory chapter some of the basic principles concerning spectra and the general laws governing light waves are briefly outlined. The production of ultraviolet rays and the various types of ultraviolet lamps are discussed in detail; this chapter includes also some data regarding the sun and its spectrum. Considerable space is devoted to the problem of measuring

ultraviolet rays and most accepted methods, including some of their advantages and disadvantages, are described. About one-third of the book has been assigned to the physical, biological and photochemical effects of ultraviolet rays and their use. The material is organized under the following headings: Fluorescence and phosphorescence, the fundamental biologic effects of ultraviolet rays, erythema and pigmentation, biologic effects of ultraviolet rays and their application in medicine, rickets and vitamin D, therapeutic lamps and their evaluation, technical application of ultraviolet lamps. A rather interesting experiment is the use of large units of ultraviolet lamps in one of the mines of the former Krupp concern. The miners take off their working clothes in one room, pass through showers and walk naked at a set rate of speed through "radiating" gangways. It is stated that in the thus irradiated group the incidence of colds, influenza and rheumatism was decreased to about 33½ per cent as compared with the non-irradiated group. The bibliography contains 953 references. As a reference work covering the literature up to 1941 this book is recommended to all working with ultraviolet radiation.

ERNST A. POHLE

PHYSICAL CHEMISTRY OF CELLS AND TISSUES. By Rudolf Höber, University of Pennsylvania School of Medicine, Philadelphia, Pa. With the collaboration of David I. Hitchcock, Yale University School of Medicine, Laboratory of Physiology, New Haven, Conn.; J. B. Bateman, Mayo Clinic, Rochester, Minn.; David R. Goddard, University of Rochester, Biological Laboratories, Rochester, N. Y.; Wallace O. Fenn, University of Rochester, School of Medicine and Dentistry, Rochester, N. Y. Cloth. Price, \$9.00. Pp. 676, with 70 illustrations. Philadelphia: The Blakiston Company, 1945.

A generation of students in cell physiology has grown up under the more or less direct influence of the successive (1902-1926) editions of Professor Höber's *Physikalische Chemie der Zelle und der Gewebe*; and the present successor volume assumes its place as a valuable aid to the advanced student and investigator in the field. The subject of the book is physiology treated "as a branch of physical chemical science dealing with life as a physical, though exceedingly complex system, that may be subjected to

scientific analysis like any other natural object."

In Section 1 (91 pages), Hitchcock expounds selected aspects of physical chemistry, viz.: diffusion in liquids; reaction velocity and enzyme action; elements of thermodynamics; electromotive force; some properties of aqueous solutions. The treatment assumes that the reader already has some knowledge of the subject. Although condensed in treatment, this subject matter is competently presented. However, the necessity for this section may well be debated in view of its restricted scope and the availability of adequate texts.

In Section 2 (121 pages), Bateman presents a valuable discussion, instructive and stimulating, of large molecules, their physicochemical properties and their architectural significance in living matter.

In the next three sections (154 pages), Höber introduces the reader to the architecture of protoplasm and discusses in considerable detail the structure and permeability of the protoplast surface, and the influence of some extracellular factors on cellular activity. The wide range and complexity of the subjects treated compel admiration for the author's industry and broad background. The student will find here many facts and much else to ponder upon.

In Section 6 (74 pages), Goddard gives a comprehensive and lucid presentation of the enzymatic mechanisms underlying the respiration of cells and tissues with emphasis on the physicochemical approach. Whether it belongs in this or another section of the book, there is unfortunately no exposition of the beautifully integrated system of gaseous, and ionic equilibria in mammalian blood (and erythrocytes) as influenced by the respiratory cycle of tissues.

The subject of tissue (particularly muscle) contractility is discussed by Fenn in Section 7 (79 pages). This includes an excellent account of the pertinent experimental observations (up to September, 1942) and of the successive theories of muscle contraction.

In the final Section 8 (87 pages), Höber considers passive penetration and active transfer in animal and plant tissue, viz.: intestinal absorption; formation of urine; permeability of the body surface of animals and plants; elaboration of digestive juices. A closing discussion deals with the energetics of active transfer, the transferring devices and their mechanics.

Because of its general content and its critical

approach to the problems of cell physiology, this book is almost an essential for those interested in the field.

BARNETT COHEN

KAROLINSKA SJUKHUSET. Redogörelse för Första Etappen av Karolinska Institutets Nybyggnader Å Norrbacka Vid Stockholm. Pa byggnadskommitténs uppdrag utarbetad av Th. Borell, Gösta Forssell och Einar Key. Cardboard. Pp. 265, with 60 illustrations and 22 plates of plans and sections. Stockholm, Sweden: P. A. Norstedt & Söner, 1944.

Through the courtesy of Professor Gösta Forssell, of Stockholm, we have recently received a prospectus of the new Caroline Hospital of the Caroline Institute of Stockholm, and it has seemed to the Editor that the readers of the JOURNAL will be glad to learn of this new institution.

The Caroline Hospital was erected by the Swedish State as a purely State institution, affiliated with the State Medical School in Stockholm, the Caroline Institute. The City of Stockholm, the County of Stockholm, and the King Gustaf V Jubileum Foundation also contributed to its construction and equipment and assist in its upkeep.

New structures built or contemplated for the Caroline Institute occupy 559,000 square meters on the outskirts of Stockholm city. The projected hospital is very elaborately described in a beautifully bound and printed book of 265 pages plus some 22 large extended drawings, showing the floor plans of the various divisions of the hospital. The institution, as projected, will have 1,056 beds, including 138 beds for the radiotherapeutic clinic. Surgical and medical outpatient departments are situated one on either side of the ground floor and the roentgen diagnostic department is one floor up.

The King Gustaf V Jubileum Clinic consists of a radiotherapeutic clinic, a radiopathological and a radiophysical department. This includes the wards, the outpatient department, therapeutic department, the offices, lecture halls, library, etc. There is also an observation ward. The radiopathological department communicates directly with the radiotherapeutic clinic. For technical reasons the radiophysical department is installed in an entirely separate building.

There is a great deal of detail in the description of the various departments. The architects'

drawings are most elaborate and contain details which would be of value to anyone interested in hospital construction.

JAMES T. CASE

JOURNAL OF THE HISTORY OF MEDICINE AND ALLIED SCIENCES. January, 1946, Volume I, Number 1. Pp. 182. Published quarterly. Subscription rate, \$7.50 in the U. S., Canada and Latin America; \$8.50 elsewhere. Single copies, \$2.50. Henry Schuman, 20 East 70th St., New York 21, N. Y.

"If a man has a sincere interest in the historical development of the knowledge of his subject, he has one of the most essential qualities of a true scholar." So said one of my colleagues, a Professor of English, in a recent informal discussion. While such a state of mind may not, to be sure, constitute all the criteria of genuine erudition, nevertheless it is a reliable single guide. As a teacher of medicine I have often pondered over the puzzling matter of why a student and many physicians will continue to use a medical term bearing a man's name, for example Thomas Hodgkin, Richard Bright or Guido Banti, day after day, without the slightest desire to ascertain who the man was, when and where he lived, and the nature of the circumstances which led to the permanent linking of his name with a certain disease state. It is difficult to comprehend why one's intellectual curiosity and depth will permit the constant use of terms and names for months or years, without manifesting some interest in their origin or historical significance.

A study of the history is not so far afield from the study of medicine. In both there is the science and the art. The scientific angle in history is compatible, at least in part, with the definition of science given by Hume, in which he says, "Science is an effectively organized body of information gained by observation, experimentation and reasoning . . . history is also . . . an art. It consists not only in collecting facts about the past, but in thinking and feeling about them. Adequate interpretation and portrayal are impossible without imagination, a sense of life, and a gift of expression." Surely some of the ways of the historian are truly

valuable ones in the training of the physician.

These statements are preliminary to welcoming to medical readers a new quarterly periodical, devoted to the history of medicine and allied sciences, of which the first issue appeared on January 1, 1946. This journal, edited by Dr. George Rosen and published by Henry Schuman of New York, in its first number of 182 pages, contains 11 articles of a high scholarly standard. This issue suggests that the critical mind of the editor will select contributions for publication which are truly of a permanent rather than a fleeting value. For this he is to be commended. There has been too much medical history written in the past which is based upon a cursory study without recourse to the original sources. While such articles may have been readable, they have not always been trustworthy or of permanent value. Such efforts cannot be classified as historical research. In reality some articles contribute nothing but fragmentary summaries of existing knowledge.

No other guarantee is needed concerning the qualifications of Dr. Rosen as an editor than to know that he is the author of one of the most comprehensive, authentic, and learned medical treatises on a historical subject which has been published in recent years, namely, "The History of Miner's Disease." For this he very appropriately received the Grant Squires prize of Columbia University in 1945.

In addition to the original articles, the first issue of the new journal contains a special section "Notes and Queries" edited by Max H. Fisch, head of the Rare Book Division of the Army Medical Library. This is a unique addition and one which will undoubtedly serve as a stimulating and informative division. The book reviews in this initial issue are contributed by George Rosen, Henry R. Viets, George Urdang, and Arthuro Castiglioni. They are exceedingly well prepared and promise to be an interesting feature of future quarterly editions.

To the editor and publisher, the reviewer extends congratulations on the first issue of the new journal. It is scholarly, readable, and has all evidences of being thoughtfully and carefully planned.

C. C. STURGIS



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SIMPLIFICATION OF ROENTGENOGRAPHY BY HIGH KILOVOLTAGE TECHNIQUE*

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OUR investigation into roentgenographic technique began in order to shorten exposure time. With no rotating anode tube at our disposal, we could not use the short exposure times that high milliamperage allows. We were also unwilling to forego the use of a small focal spot.

To shorten the exposure time the peak kilovoltage was raised, and much to our surprise, good roentgenograms were obtained at 85 kv. (peak) for all routine Bucky work. Although our machine had a double focus tube, only the small 2.0 mm. spot was used, with 30 milliamperes. All non-Bucky screen roentgenograms were made at 75 kv. (peak), 10 ma. For 6 ft. chest films, 75 kv. (peak), 100 ma., and large (4.5 mm.) focal spot were the factors employed. Chart 1 gives all the technical factors used.

This simplified technique proved satisfactory, and had the following advantages:

1. Rapid exposures could be made without a rotating anode tube and without high milliamperage equipment, still using the small focal spot.

2. Roentgenographic technique was greatly simplified; troublesome measurements and autotransformer manipulations were eliminated.

3. The same technical factors gave good roentgenograms over a wide range of thicknesses, making unsatisfactory films uncommon.

4. The soft tissues were well visualized without underexposing the bony structures.

5. Because of the technical simplicity, re-examinations were of similar density.

6. The skin received only 10-30 per cent of the radiation usually received in roentgenography.

7. Life of the roentgen tube was undoubtedly prolonged.

The only disadvantage was the decreased contrast of the roentgenograms. However, only the "beauty" and brilliance of the roentgenogram were sacrificed; the diagnostic quality was not lowered, and frequently was enhanced.

Shorter wavelengths have been suggested for soft tissue roentgenography by some workers.^{1,2,5,6} High filtration rather than high kilovoltage was employed to obtain shorter wavelengths.

At 75 and 85 kv. (peak) we were obviously employing shorter wavelength radiation. In such a beam, the number of "long" wavelengths are relatively few and do not enter significantly into the film effect.

The merit of the high peak kilovoltage technique, in the final analysis, must be measured mainly by the quality of the roentgenograms obtained. The figures in the text illustrate some of the routine roentgenograms obtained by this technique. Although of less contrast than the best conventional roentgenograms, the diagnostic

* Data from United States Public Health Service Dispensary, Washington, D.C.

CHART I

Part Examined	Distance (inches)	Kv. (peak)	Ma.	Time (seconds)	Ma-Sec.
	Non-Bucky	Screen			
Chest—posteroanterior	72	75	100	1/10-1/20	5-10
Chest—oblique	72	75	100	1/10-2/10	10-20
Chest—lateral	72	75	100	1/10-1/4	10-25
Cervical spine—anteroposterior	72	75	100	1/10	10
Cervical spine—lateral	72	75	100	1/10	10
Hand—anteroposterior—oblique—lateral	36	75	10	1/10	1
Wrist—anteroposterior—lateral	36	75	10	1/10	1
Forearm—anteroposterior—lateral	36	75	10	1/10	1
Elbow—anteroposterior—lateral	36	75	10	1/10	1
Humerus—anteroposterior—lateral	36	75	10	3/20-2/10	1.5-2
Foot—anteroposterior—oblique—lateral	36	75	10	1/10	1
Os calcis—inferosuperior	36	75	10	3/10	3
Ankle—anteroposterior—lateral	36	75	10	1/10	1
Leg—anteroposterior—lateral	36	75	10	1/10-3/20	1-1.5
Knee—anteroposterior—lateral	36	75	10	1/10-3/20	1-1.5
Thigh—anteroposterior—lateral	36	75	10	3/10	3
Chest—infants	36	75	10	1/20	0.5
Sinuses—Waters	26 + (cone)	75	10	1.0	10
Sinuses—Caldwell	26	75	10	0.9	9
Sinuses—lateral	26	75	10	0.3	3
Sinuses—base	26	75	10	1.5	15
Mastoid—anteroposterior (tips)	26	75	10	1/10	1
Mastoid—lateral	26	75	10	3/10	3
Nasal bones	26	75	10	1/10	1
	Bucky	Screen			
Anteroposterior abdomen (gastrointestinal tract, barium enema, gallbladder, pyelogram, pelvis)	36	85	30	0.5-1	15-30
Lumbar spine—anteroposterior	36	85	30	0.6-1.2	18-36
Lumbar spine—lateral (including lumbosacral joint and sacrum)	36	85	30	4-8	120-240
Dorsal spine—anteroposterior	36	85	30	0.8-1.5	24-45
Dorsal spine—lateral	36	85	30	0.8-1.2	24-36
Shoulder—anteroposterior	36	85	30	3/10	9
Skull—posteroanterior	36	85	30	0.8	24
Skull—anteroposterior	36	85	30	1.0	30
Skull—base	36	85	30	1.5	45
Skull—lateral	36	85	30	3/10	9

quality is not impaired; frequently the roentgenograms are diagnostically superior.

Sharpness is not decreased by this technique. Rapidity of exposure and the use of the small focal spot will tend to increase sharpness. Although high peak kilovoltage radiation will cause more oblique and horizontal scattering,⁴ in the thicker parts the scattered components are removed by the moving grid; in the thinner parts there are not enough scattered components to

make appreciable film differences. Morgan,⁷ in his studies with the exposure meter, found strikingly similar roentgenograms made with the kilovoltage varying from 30 to 80 kv. (peak).

Certain advantages of the high peak kilovoltage roentgenograms are striking. The excellent soft tissue visualization is of great diagnostic value. Bones are thoroughly penetrated, with the overlapping portions clearly visible. Thinner bony structures are not "burned out." The use of

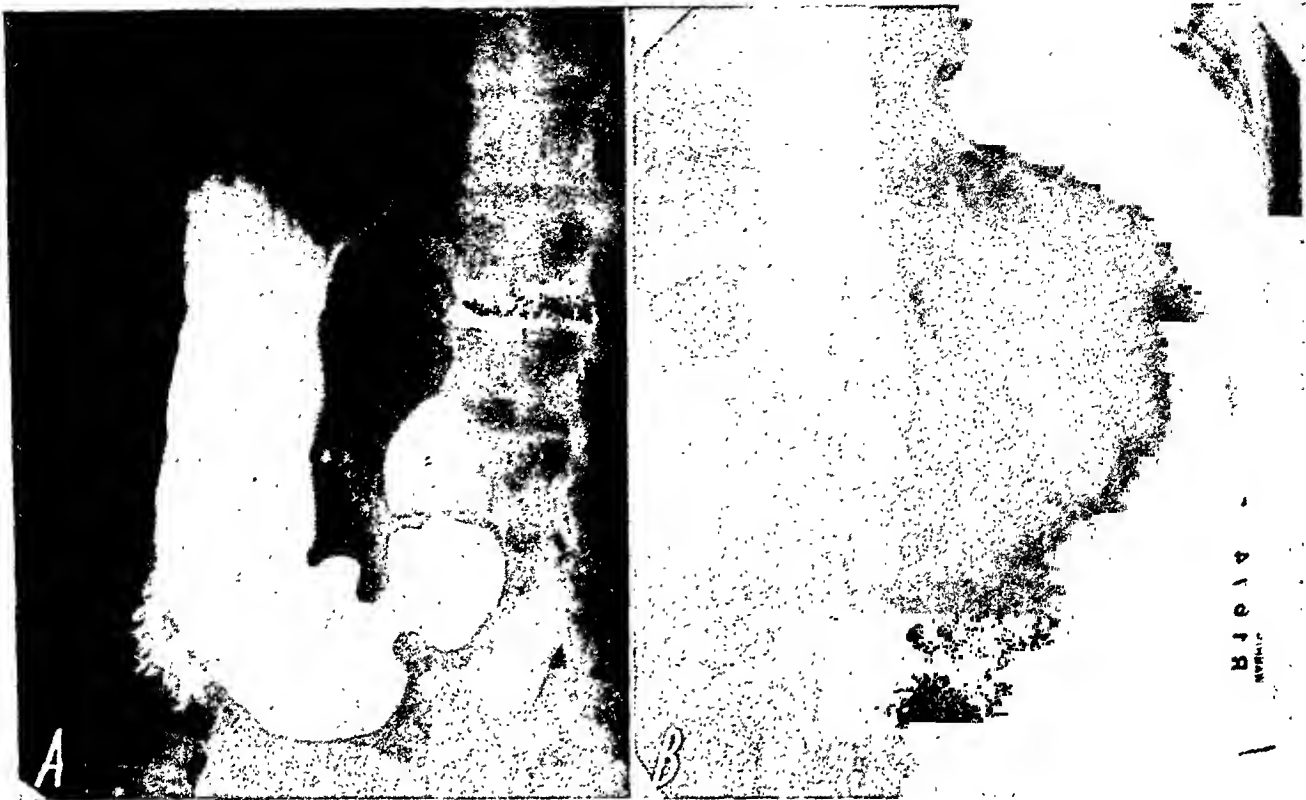


FIG. 1. *A*, gastric roentgenogram made with 85 kv. (peak), using Bucky grid. *B*, cholecystogram made at 85 kv. (peak).

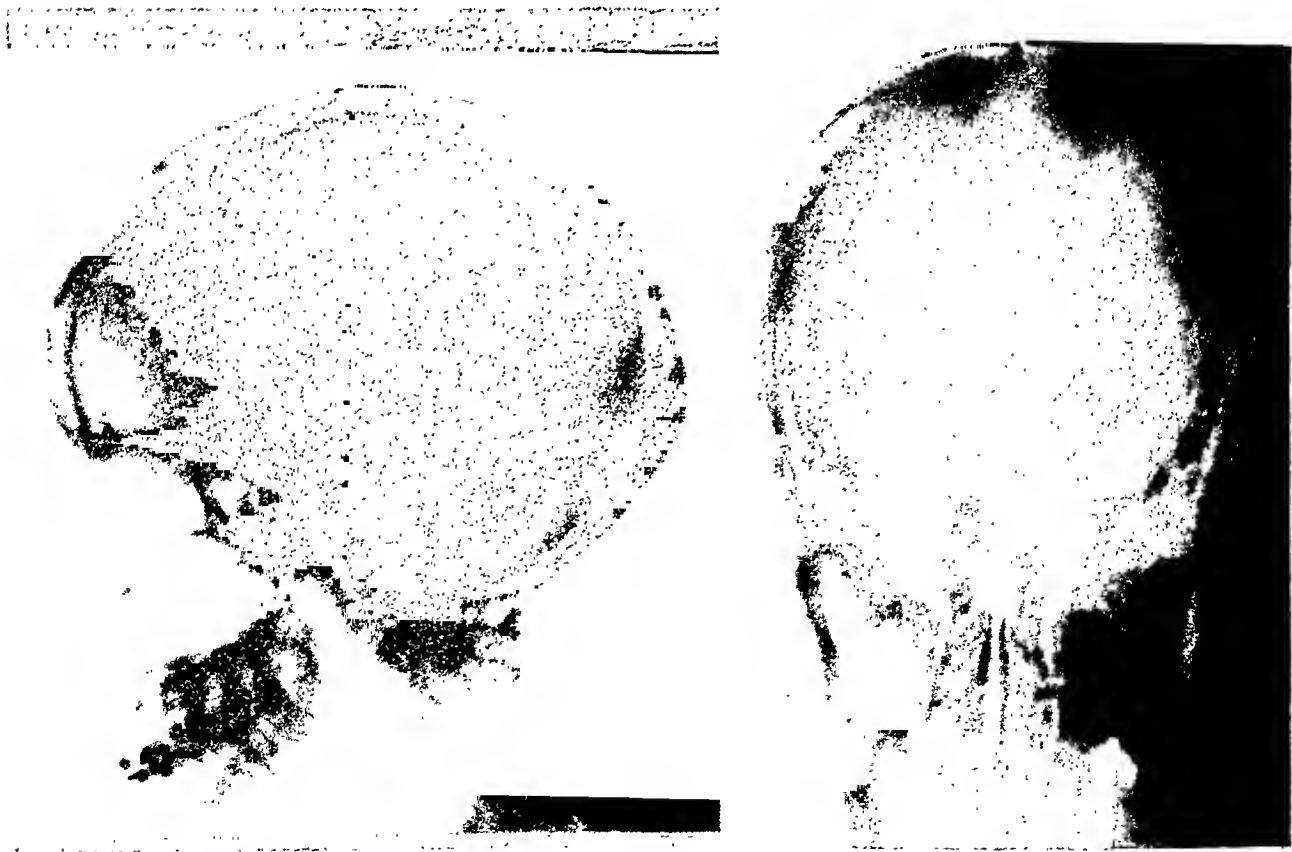


FIG. 2. Roentgenograms of the skull made at 85 kv. (peak), using Bucky grid.

the brilliant spotlight becomes unnecessary.

In the chest roentgenograms, the troublesome breast shadows become almost transparent. The lung fields are no longer brilliant below the clavicles and overcast at the peripheries. The homogeneous appearance

The high peak kilovoltage technique offers real simplification of routine roentgenography. Since only two kilovoltage settings are used, and since there is a large margin of safety, a novice technician will quickly learn routine technique and produce satisfactory roentgenograms. No

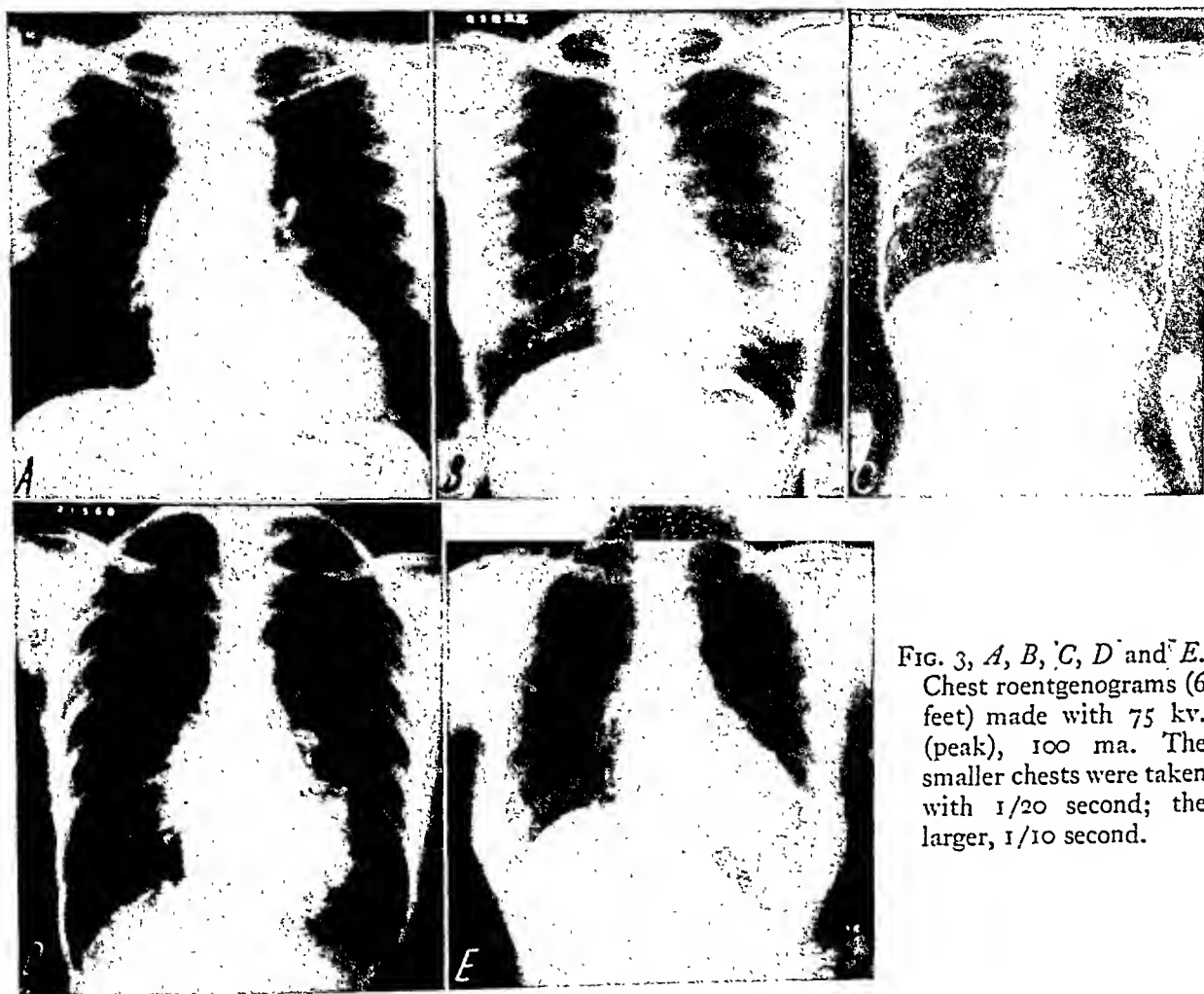


FIG. 3, A, B, C, D and E. Chest roentgenograms (6 feet) made with 75 kv. (peak), 100 ma. The smaller chests were taken with 1/20 second; the larger, 1/10 second.

from apices to diaphragms simplifies chest interpretation. Lesions behind the heart are exposed through the well penetrated heart shadow. Every re-examination is a remarkable replica of the previous roentgenogram.

Where extreme contrast is needed to give additional diagnostic information, a re-examination is made using a lower peak kilovoltage. The number of retakes for this reason is far less than the number of retakes when the conventional technique is used.

measurements are necessary. Bothersome kilovolt settings, commonly a mental hazard to technicians, are eliminated. The same technical factors suffice for similar parts, regardless of moderate variations in thickness. It is remarkable that satisfactory chest roentgenograms are obtained with 75 kv. (peak), 100 ma., at 1/20 second, both for children and medium sized adults. It is also striking that for anteroposterior and lateral views of the wrist, arm, elbow, ankle, leg and knee, the technical factors are iden-

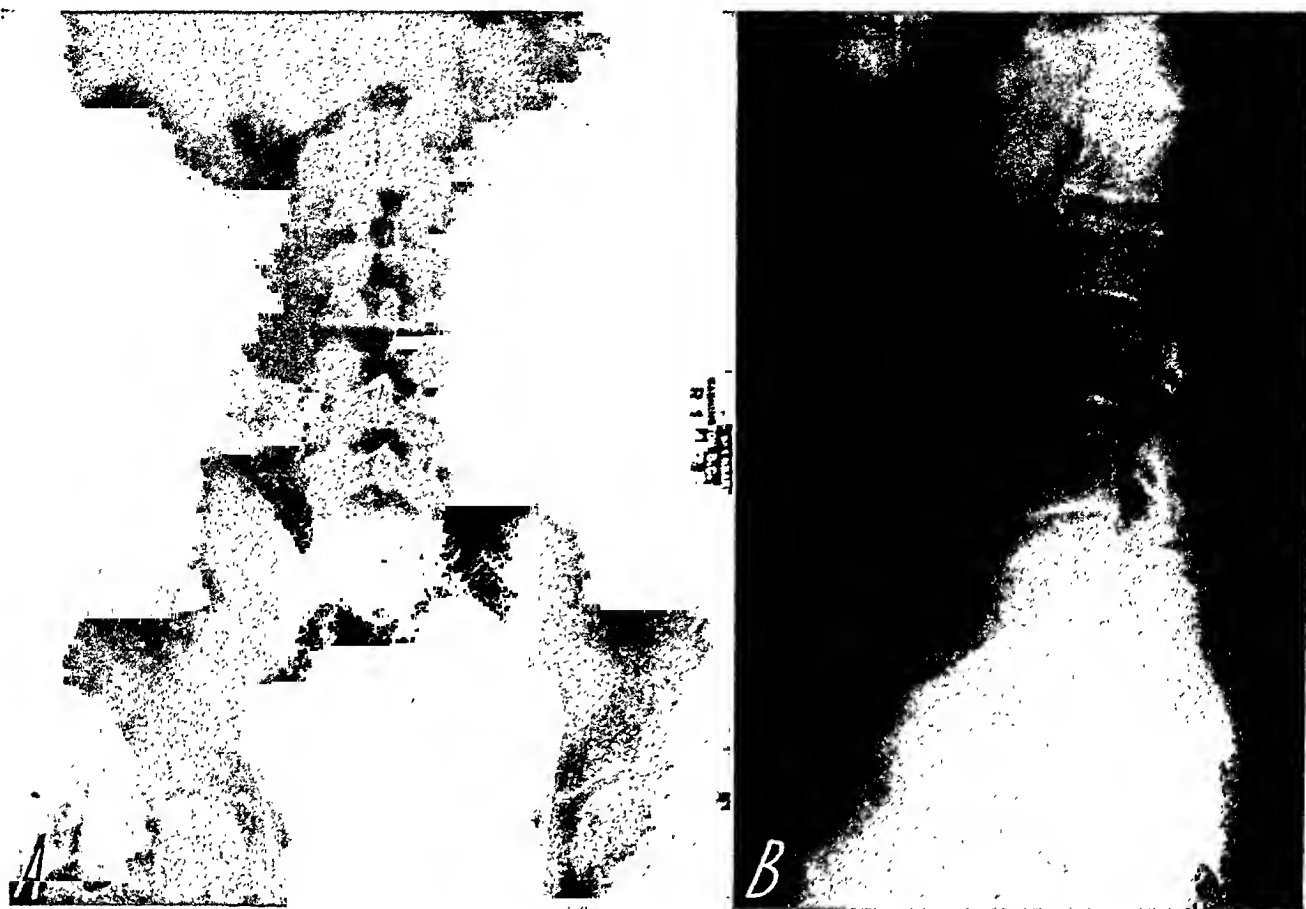


FIG. 4, *A* and *B*. Roentgenograms of the lumbar spine and pelvis made with the 85 kv. (peak) technique.

tical. It is obvious that poor exposures will be unusual, and re-examinations remarkably constant.

All exposures are relatively rapid, and the small (2.0 mm.) spot is used. With this technique, the only advantages a rotating anode tube offers are a higher milliamperage and shorter time when the Bucky grid or the 1.0 mm. spot is used. A machine powered to give up to 100 ma. is quite satisfactory.

We were greatly interested to learn that a step towards technique simplification has been made by Fuchs³ for use in military roentgenography. A basic peak kilovoltage is set for all parts, and the milliampereseconds are varied for thickness differences. He classifies all parts as average, small or large. The milliampereseconds are doubled for the large and halved for the small. While this is a definite step in the right direction, there still remains a confusingly large number of peak kilovoltage settings to be remembered.

The life of the roentgen tube should be greatly increased with the high peak kilovoltage technique. For a full wave rectified apparatus, at 85 kv. (peak) and 30 ma., the maximum exposure time allowable for the 2.0 mm. spot is 20 seconds. With our

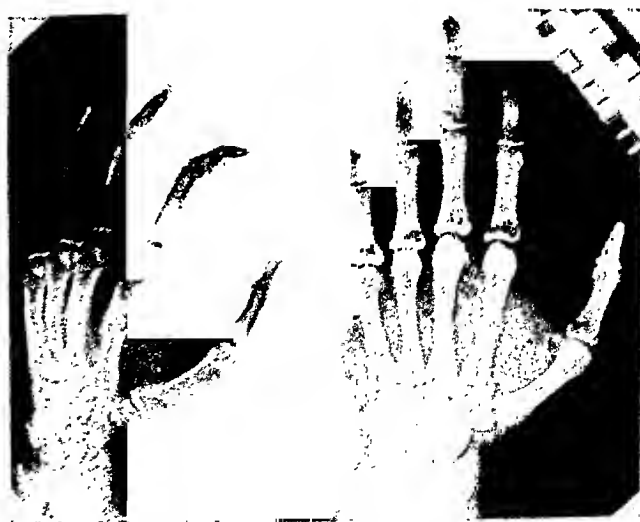


FIG. 5. Each of these roentgenograms of the extremity was made with 75 kv. (peak); 10 ma.; 1/10 second; screen at 36 inches.



FIG. 5, Continued.

technique, 8 seconds is the longest necessary exposure time (low lateral pregnancy film), with the majority less than 1 second. The large spot used in chest roentgenography allows 5 seconds exposure at 100 ma., 75 kv. (peak). At most (lateral chest— $\frac{1}{4}$

second) only 5 per cent of capacity is utilized.

A careful study of the roentgen output of our machine at various kilovoltages indicated that with the high peak kilovoltage technique (using no added filter), the skin

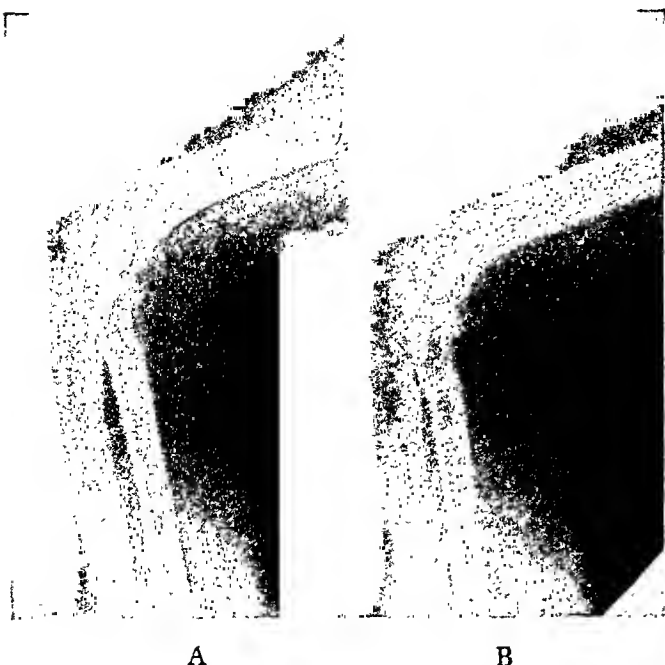


FIG. 6. Lateral roentgenograms of the elbow. *A*, 48 kv. (peak); *B*, 85 kv. (peak). The films were developed simultaneously. Note the better soft tissue delineation in *B*. The decreased contrast in this roentgenogram in no way impairs its diagnostic quality.



FIG. 8. Lateral roentgenogram of the cervical spine made at 6 feet using chest technique (75 kv., peak; 100 ma.; 1/20 second). Note visualization of the seventh cervical lumbar vertebra. This vertebra is consistently visualized by this technique.

dosage is reduced to 10–35 per cent of the radiation usually received in roentgenography. A complete report on this interesting and important advantage will be made in a later publication.

While the 75–85 kv. (peak) method described above proved simple and quite

satisfactory, these are quite arbitrarily chosen kv. (peak) values. In the course of our experimenting, we found that a 65–75 kv. (peak) system (65 kv., peak, for non-Bucky; 75 kv., peak, for Bucky films) is also adequate and simple, giving somewhat better contrast. Certainly any fixed kv.

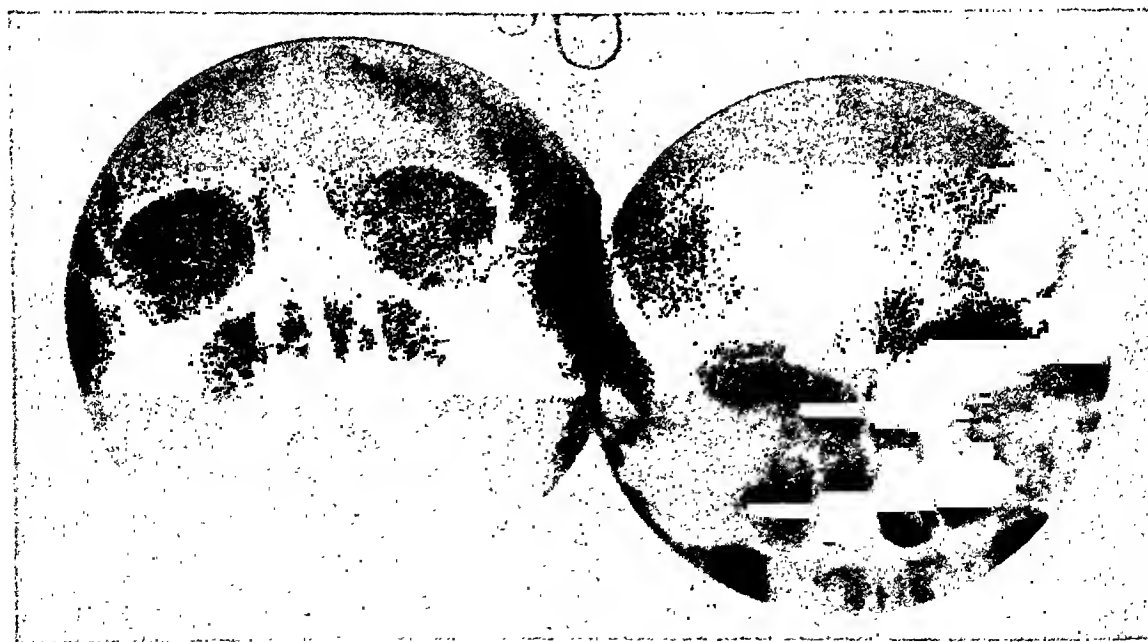


FIG. 7. Sinus roentgenograms made at 26 inches, with cone, using the 75 kv. (peak) technique.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

SKELETAL SYSTEM

JUNGMANN, H., and STERN, V. S. An unusual case of joint disease (a possible example of arthritis psoriatica). *Brit. J. Radiol.*, Dec., 1944, 17, 383-385.

A woman of fifty-one had had sudden pain and swelling in her finger joints twenty years ago; it soon spread to other joints. Eighteen years ago she was admitted to hospital and has been bedridden since. Her limbs were drawn up so that she could not use them and she complained of severe pain all over her body and sleeplessness due to pain. She was very much emaciated with great atrophy of the muscles. Her hands and fingers were the size and appearance of those of a child of seven. There were no active or passive movements of the lower limbs. There were big irregular red patches on her skin which showed much scaling. The base of the ulna had disappeared and while the base of the radius still showed some signs of normal shape the joint space was completely obliterated. On the right side the carpal bones except the pisiform had completely disappeared; on the left some residues of the scaphoid and capitatum could be seen. The metacarpals were short and plump and tapering at the ends. Some of the phalanges had completely disappeared and the rest were tapering. The bones of the foot showed the same changes but to a lesser degree. Roentgenograms of the hands and feet are given.

Joint lesions in psoriasis were first observed in France during the first half of the last century. A number of cases have been reported in the literature in the United States. The joint changes generally occur after the skin lesions have begun but in this case and a few others the joint lesions seem to develop first. Bone destruction is generally not so severe as in this case. The author believes the two diseases are coordinated, that is that they are the result of the same agent acting on two different systems. —Audrey G. Morgan.

HOWORTH, M. BECKETT. Calcification of the tendon cuff of the shoulder. *Surg., Gynec. & Obst.*, April, 1945, 80, 337-345.

Codman and others have demonstrated that the condition called subdeltoid bursitis, or periarthritis, is in reality a lesion of the tendon cuff of the shoulder. It may be a calcification, a tear, or a "tendonitis." Calcification of the tendon cuff is probably the most common cause of pain and disability at this joint.

Anatomy. The tendons of the subscapularis, supraspinatus, infraspinatus, and teres minor muscles converge and fuse with the capsule of the shoulder joint about 1 inch from its distal margin. The common tendon capsule cuff thus formed is attached to the superior margin of the tuberosities and the anatomic neck of the humerus. The subdeltoid or subacromial bursa lies upon this tendon cuff and the greater tuberosity, and is covered by the deltoid muscle, acromion process, and coraco-acromial ligament. It is a thin-walled, transparent, hemispherical pouch, averaging about $1\frac{1}{2}$ inches in diameter, and lined with synovial membrane.

Pathology. The bursa and calcareous deposit were exposed at operation in 23 shoulders. The bursal wall was usually thickened and opaque, edematous and vascular.

The calcareous deposit could be identified in the floor of the bursa as a white or yellowish area, often a raised wound resembling a "boil," surrounded by a reddish zone.

The degenerated tendon often was infiltrated with calcareous granules or clumps. Bare bone was exposed in the base of some of the cavities. No communication with the joint was demonstrated, and only one had ruptured into the bursa. Most of the deposits were in the tendon of the supraspinatus, but there were several in the infraspinatus and the teres minor, one in the subscapularis muscle.

Etiology. The cause of the calcification was not obvious, but it appeared that there had been first a degeneration of the tendon followed by the deposition of calcium salts. The degeneration may be the result of impaired circulation, attrition, or both. The supraspinatus tendon, with the arm at the side, makes a curve of about 40 degrees around the head of the humerus to its insertion. Thus the use of the arm at the side, with sudden, jerky, or resisted motions toward abduction or rota-

tion, constantly repeated, appears to be the cause of degeneration and calcification of the tendons of the shoulder cuff.

Course and Stages. The symptoms and signs of this disease are not proportional to the size, shape and number and location of the calcareous deposits, nor even to their type. It is probable that the most important factor in relation to the severity of symptoms and signs is the tension of the calcareous material in the substance of the tendon.

The calcareous deposits often increase, occasionally decrease in size and density over a period of months or years, but may change in a few days. Rupture of the deposit into the bursa results in a change in the location and density of the calcareous material and is usually followed by immediate relief of symptoms and absorption of the material. Occasionally the deposits in the tendons are absorbed, but most of them persist for many years unless there is a spontaneous or surgical opening.

There is usually little correlation between the clinical and roentgenographic features of the disease.

Cases. One hundred consecutive cases have been included in this series. The average age was forty-three years, the range from twenty-four to sixty-three. Only 1 patient was under thirty years, 12 past fifty years. Forty per cent were men, 60 per cent women. The right shoulder was affected in 62 per cent, the left in 38 per cent, 14 per cent being bilateral. Definite injury was mentioned in only 3 cases. House-keeping was the most common occupation.

Symptoms and Signs. The symptoms were pain, limitation of motion, and disability. The duration of symptoms was two days to twenty years, averaging two years.

The pain was usually described as an ache in the anterior shoulder region, often radiating down the anterior border of the deltoid to its insertion. The pain overflowed into the forearm and upper shoulder girdle region in the more severe cases. It was worse at night, making it difficult to find a comfortable position in bed, especially on the affected side. The pain was worse on activity, and often affected by weather. Abduction, or putting the hand behind the head, was difficult or impossible.

The arm was usually held at the side in internal rotation. There was atrophy of the deltoid and spinatus muscles. Tenderness of various degrees was found, usually anterolaterally just above the greater tuberosity be-

cause of the more frequent involvement of the supraspinatus muscle. The tenderness was lateral to the tuberosity with involvement of the infraspinatus, posteriorly for the teres minor and anteromedially for the subscapularis.

Roentgenograms. The typical roentgenogram revealed an amorphous calcification in the angle between the humeral head, greater tuberosity, and acromion. Usually there was one main mass, once as many as five. The supraspinatus calcifications were located just above the junction of the greater tuberosity and head, whereas those of the infraspinatus and teres minor were lower and superimposed upon the tuberosity except in internal rotation; that of the subscapularis was superimposed on the joint in internal rotation, on the head in external rotation.

The roentgenogram should be made tangential to the acromiohumeral interval, and views should be made in 45 degrees, internal, and 45 and 90 degrees external rotation, as well as in the neutral position.

Treatment. Operative removal of the calcareous deposit is the surest and quickest method of relief, particularly in the chronic cases.—*Mary Frances Vastine.*

WEENS, H. S. Calcification of the intervertebral discs in childhood. *J. Pediat.*, Feb., 1945, 26, 178-188.

Reports are conflicting as to the significance of calcification of the intervertebral discs in the adult. Recent reports indicate that such calcification can exist in the absence of symptoms. From the few case reports of calcification of the intervertebral discs in childhood, it seems probable that the condition is of more pathological significance since all cases reported showed definite clinical signs and symptoms.

The author reports a case of a five year old girl whose chief complaint was marked pain in the neck and back of the head. The symptoms had been present in a mild form for two months and had been severe for five days. An injection of novocain, following a tentative diagnosis of myositis, did not relieve the symptoms. Physical examination showed hyperextension of the neck with resistance to flexion. There was a slight hyperpyrexia which disappeared two days after admission to the hospital and two days later all pain had disappeared. Laboratory studies were essentially negative. Roentgen examination revealed a dense calcification, 6 by 5 by 2 mm., in the interspace between the

bodies of the sixth and seventh cervical vertebrae, extending from the anterior portion of the disc to its mid-portion. Review of a chest film which had been made seven months prior to hospitalization showed the lesion to have been present at that time. The calcification disappeared completely within four months.

The author summarizes 5 cases of calcification of the intervertebral discs in childhood from the literature. In all cases there was pain in the back or neck, localized to the area of the spine in which calcifications could be demonstrated. The attacks lasted from two weeks to several weeks. Where the cervical discs were involved limitation of motion of the head and neck was noted. Fever accompanied the symptoms in most cases. In all cases the calcification was in the nucleus pulposus. In adults this type of calcification is usually considered to be degenerative in nature but in the cases occurring in childhood this explanation would not apply. Trauma was a possible factor in only 1 case. The limitation of the process to a single intervertebral space would tend to rule out a general metabolic disturbance. Calcification following an aseptic necrosis such as occurs in other bones is a distinct possibility. The fact that the condition occurs in the presence of fever, leukocytosis and an increased sedimentation rate supports the theory that the calcification may result from a metastatic infection. The author apparently favors this latter theory.

Weens contrasts calcification of the intervertebral discs as it occurs in children and in adults. In the former the cervical spine is usually involved while in adults the dorsal and lumbar spines are the common sites of involvement. In the second place the calcifications in adults are practically stationary whereas in children they appear and disappear rapidly. Finally, the condition is asymptomatic in adults but is accompanied by signs of infection in the child.—*R. M. Harvey.*

MOORE, ROBERT DUNHAM. Conservative management of adolescent slipping of the capital femoral epiphysis. *Surg., Gynec. & Obst.*, March, 1945, 80, 324-332.

The methods employed, and the results in the treatment of 44 cases of adolescent epiphysiolysis in various stages of displacement are reported. Reposition of the epiphysis was not usually attempted, and was not accomplished in any case except in those in which there was recent complete separation of the epiphysis

following sudden trauma. The summary and conclusions are:

1. Of 26 hips with minimal displacement of the epiphysis, good function was obtained in 88.5 per cent following immobilization and protection of the affected hip until ossification of the capital epiphyseal growth cartilage took place.

2. Good function was obtained in 47.8 per cent of 23 hips with moderate displacement of the epiphysis following the conservative plan of treatment outlined. Thirteen per cent resulted in fair function, and 21.7 per cent had poor results. In only 1 case, or 4.4 per cent of the total, could the poor result be attributed to treatment. Results in the remaining 17.5 per cent of the cases are not known.

3. Satisfactory replacement, a living epiphysis, and a normally functioning hip followed prolonged adhesive skin traction and immobilization in 1, or 33.3 per cent, of 3 cases with complete separation. In 2 cases, poor results were due to necrosis of the epiphysis.

4. Epiphyseal necrosis may occur naturally in cases with minimal displacement. It is not uncommonly present in cases with moderate displacement first seen after bony union of the epiphysis has occurred. It is frequent following complete separation of the epiphysis due to sudden trauma.

5. Death of the epiphysis, as a complication following manipulative or surgical reposition of the epiphysis, is reported in a relatively high percentage of such cases in the literature. This disturbance was not a complication in this series of cases in which adequate conservative treatment was employed.

6. The methods used in the care of these patients are in contrast to manipulative or operative measures of treatment which increase the probability of interruption of the blood supply to the epiphysis. Long term evaluation of these divergent methods, with reference to late disability from traumatic arthritis, cannot be made until follow-up studies of representative series of such cases have been made twenty to thirty years after treatment.—*Mary Frances Pastine.*

MOORE, ROBERT DUNHAM. Aseptic necrosis of the capital femoral epiphysis following adolescent epiphysiolysis. *Surg., Gynec. & Obst.*, Feb., 1945, 80, 199-204.

Adolescent slipping of the capital femoral epiphysis is not infrequently followed by oc-

clusion of the blood supply to this epiphysis. This complication occurs as the result of damage to the blood vessels of either the visceral capsule or the ligamentum teres during the period of progressive displacement. It may follow the trauma of surgical or manipulative procedures undertaken to replace and fix the epiphysis in its normal position on the neck of the femur. Subsequent distortion of the shadow of the head, narrowing of the shadow of the articular cartilage, and irregular density of the ossification center are usually seen in the roentgenogram. These findings may be accompanied by pain, deformity, and progressive loss of motion of varying degree.

During the early growing period the articular cartilage appears to be less dependent upon the circulation of the underlying bone. With interruption of the blood supply to the ossification center, the synovia may furnish adequate nutrition to the cartilage which continues due to proliferate, and thus becomes thicker than normal as in Legg-Perthes' disease. Restoration of the circulation to the underlying bone leads to creeping replacement of the necrotic bone followed by resumption of endochondral ossification, but the shadow of the articular cartilage on the roentgenogram usually remains slightly wider than that of the normal side due to this discrepancy between growth of the cartilage and replacement of its deeper portion by bone.

Even in adolescence, near the end of the growth period, the articular cartilage may remain alive after devitalization of the underlying bone. However, the rate of growth of the cartilage at this age is much slower than that of the younger child and cessation of endochondral ossification may not lead to any appreciable increase in the depth of the articular cartilage as is seen in Legg-Perthes' disease. In the young adolescent it appears that much of the deeper bone of the cartilage may undergo degeneration and subsequently become ossified after revascularization of the underlying bone. If such degeneration involves much of the deeper portion of the cartilage, ossification of this zone may actually lead to narrowing of this structure.

Summary.

1. In the first case reported by the author, the bone of the epiphysis underwent necrosis but most of the articular cartilage remained alive. Bony union occurred, and at the end of one year about two-thirds of the dead bone had

been replaced by new bone. The articular cartilage was narrowed as its deeper zone had undergone degeneration and ossification, and growth of its superficial zone and had been inadequate to preserve the normal depth of this structure.

2. In the second case there was nonunion and both ossification center and articular cartilage underwent absorption and fibrocartilaginous replacement or ossification during the process of repair. Only a small amount of the necrotic bone had been absorbed and replaced by new bone.

The acetabular cartilage in 1 case appeared to remain viable. Early degenerative and reparative changes in this structure were noted.

The synovial membrane in both cases showed chronic nonspecific inflammatory changes.—*Mary Frances Vastine.*

McELVENNY, ROBERT T. Roentgenographic interpretation of what constitutes adequate reduction of femoral neck fractures. *Surg., Gynec. & Obst.*, Jan., 1945, 80, 97-106.

The suggestions for standardization of what constitutes adequate reduction of intracapsular femoral neck fractures are presented. These suggestions are the result of studying numerous roentgenograms over a six year period and of attempting to find certain characteristics which were present in those roentgenograms in cases that were successful but which did not obtain in roentgenograms of cases that were not successful.

1. The method described for obtaining reduction of femoral neck fractures is based on complete relaxation under an anesthetic and then pulling the limb down in external rotation and slight abduction. While traction is on, gentle flexion and toggling of the hip is carried out until the neck passes the head. The limb is then internally rotated in its limit. No resistance should be felt in carrying out this maneuver. The patella should face directly medially and the internal femoral condyle should be directly on the small sandbag that supports the knee. When this position is obtained, the limb is abducted to neutral or slightly beyond. An anteroposterior and, if desired, a lateral film is now taken.

2. If in the anteroposterior view, the criteria are satisfied, the guide is inserted, the guide wire is put in, and anteroposterior and lateral views are now taken. If the wire is perfectly

centered in both views and the hip is reduced in both views, the nail is driven home. Anteroposterior and lateral roentgenograms check the depth and position of the nail and the reduction. If these are satisfactory, the guide and guide wire are withdrawn and the wound is closed.

3. The reduction described is applicable to the operating room and a flat wooden table with a cassette box under its top proves as satisfactory as any table,

4. All standards described in this paper are based on roentgenograms taken with the limb in full internal rotation. In this way the neck length is established. If the head and neck are separate from one another and there are no overlapping shadows where a portion of the neck covers a portion of the head. If overlap is present, it means that a complete reduction has not been obtained because if complete internal rotation is present any overlap indicates overriding or angulation, but not end-to-end contact. Any roentgen view short of complete internal rotation distorts the relationship of the head and neck and makes interpretation of the film practically worthless.

5. A satisfactory reduction is one in which the limb is in complete internal rotation and at least neutral lateral position. The neck fragment is *well under and well inside* the head fragment as shown in the anteroposterior view. In the lateral view the head and neck are in line with no angulation and no overlap. The fracture surfaces are apposing one another.

6. A satisfactory fixation is one in which the fixation material enters the shaft of the femur *at or below the level of the lesser trochanter*, runs through the lower one-half of the neck parallel to the calcar femorale, and centers the head in both planes.

7. The main purpose of the fixation is to act as a guide which allows the head to settle on the neck in a position in which the weight thrust is directly applied to the fracture site without shearing or torsion forces being exerted on the fixation material.

8. The author wishes to stress that all his failures have occurred in hips that have been imperfectly reduced. That is, the neck fragment has not been placed well under and well inside the head fragment.

9. If a hip cannot be reduced or if there is doubt as to the effectiveness of reduction, either an immediate intertrochanteric or a subtrochanteric osteotomy should be performed.—*Mary Frances Vastine.*

HAGGART, G. E., HARE, HUGH F., and MARKS, J. H. Clinico-pathological conference [osteochondrosarcoma]. *Radiology*, Oct., 1944, 43, 378-382.

The subject of this conference was a man of thirty-three admitted to the Lahey Clinic September 7, 1943, for a tumor of the right thigh of two years' duration. He had been given Coley's fluid in July and 1,000 r in divided doses. From the physical and roentgen findings a diagnosis of sarcoma of undetermined type of the inner proximal right thigh was made. Operation was advised and the patient told that the tumor was probably malignant. On the advice of his local physician he refused operation. He wrote in February, 1944, saying that he was disabled on account of increasing pain and asked for admission to hospital for whatever treatment was thought advisable. He was admitted to the New England Deaconess Hospital March 28, 1944, and after a careful consideration of the dangers of radical surgery and the inevitable serious consequences without surgery, excision was decided on.

Operation was performed in two stages, the first stage being a ligation of the right hypogastric artery. In the second stage the ischio-rectal fossa was exposed and found to be completely filled by the tumor which pressed directly against the rectum and extended downward into the thigh. It originated from the rami of the right ischium and pubis and formed a large mass 25×15 cm. in size which was encapsulated and appeared to be benign. It was removed en bloc and the muscles which had been detached to reach it were reattached. The patient was given a transfusion 500 cc. of blood during the operation. He made an uneventful recovery and the wound healed by first intention. Microscopic examination showed that the tumor was an osteochondrosarcoma.—*Audrey G. Morgan.*

BLOOD AND LYMPH SYSTEM

CORCORAN, WILLIAM J. Erythroblastic anemia. *Radiology*, Oct., 1944, 43, 373-375.

Erythroblastic anemia or Mediterranean anemia is seen only in races in the Mediterranean area, particularly Greece and Italy. It is a slowly progressive anemia with a large number of nucleated red cells. All methods of treatment so far have proved ineffective though Borzell reports that one of his patients improved under roentgen treatment. The spleen is

enlarged and the patients have a mongoloid appearance. There is osteoporosis of the long bones and often pathological fractures. The space between the tables of the skull is widened and the outer table becomes so thin that it cannot be seen on the roentgenogram. The trabeculae between the inner and outer tables give the appearance of hair standing on end.

A case is described in a boy eight years of age of Italian parentage admitted to hospital in Carbondale, Pa., April 15, 1943, for a roentgen examination of the left femur. The bone was found completely fractured at the lower third. Further examination showed the skull characteristic of erythroblastic anemia. Roentgenograms of the femur and skull are given. The blood count showed 2,750,000 red cells, 14,000 leukocytes and 44 per cent hemoglobin; there were 10 to 15 nucleated red cells to the oil immersion field.

The patient left the hospital after the fracture healed. Later splenectomy was performed at another hospital. On January 3, 1944, he was alive but in poor condition.—*Audrey G. Morgan.*

GENERAL

BELL, JOSEPH C., and HEUBLEIN, GILBERT W. Diagnostic roentgenology in an army general hospital during the present war. *Radiology*, Nov., 1944, 43, 425-485.

This article is a memorial lecture delivered in honor of Dr. Preston M. Hickey who was one of the pioneers in establishing radiology in the Army General Hospitals where it is now firmly established. The radiologist in the Army general hospital has an opportunity to see a wide range of cases and to follow them up as the patients are kept until all that is possible has been done for them and this often involves a treatment extending over many months. The Percy Jones General Hospital at Battle Creek, Michigan, has a well equipped roentgen department and the work there is discussed in detail. Roentgenograms are given of lesions in the various systems and regions of the body and illustrative cases described. Photographs are also given of the various types of equipment used and a map of the world given showing the various parts of the battle front from which patients have been sent to this hospital.—*Audrey G. Morgan.*

PATTERSON, RUSSEL H., and ANDERSON, FRED M. War casualties from prolonged exposure

to wet and cold. *Surg., Gynec. & Obst.*, Jan., 1945, 80, 1-11.

The observations in this article that are of particular interest to the radiologist are included under the following headings:

Gas-Infection and Roentgenological Findings. Three patients with extensive gangrene, in whom anaerobic cultures were consistently negative, showed by roentgen examination multiple circumscribed rarefied areas in the soft tissues of the feet.

The significance of such roentgenological findings is at times doubtful as separation and retraction of dry gangrenous tissues, as well as liquefaction of tissue, will alone or in conjunction with gas-forming organisms, produce similar changes in tissue density. Such changes may also be produced by other organisms such as anaerobic streptococci, along with various aerobes, as *Streptococcus pyogenes* and *Staphylococcus pyogenes*. One differential point is that changes in tissue density which are due to retraction or liquefaction generally manifest themselves slowly and may vary little from week to week, while changes due to gas gangrene may come on more suddenly and spread more rapidly, the more severe cases being accompanied by symptoms and signs of toxicity.

All patients in which gas bacillus infection was suspected, in addition to sulfa drugs or penicillin or both, were given prophylactic roentgen treatment of 50 to 100 r twice daily for three to five days, as advised by Kelly and Dowell.

The roentgenograms revealed in most cases a calcification of nearly all the bones of the feet, probably due to immobilization. Where complete deep necrosis had taken place and there was loss of blood supply to the tissues, the bones were white and dense, little or no calcium being lost.

Foot Deformities. A majority of patients seen, even including those with only second degree damage, developed a foot deformity. This was generally of a claw foot type, with varying degree of pes cavus. The great toe was pulled downward into plantar deformity and the intervals between all of the toes was increased.

The mechanism of production of the rather characteristic foot deformity is probably as follows: The muscles of the foot consist of two groups—the long extrinsic ones from the leg and the short intrinsic ones within the foot. There are flexors and extensors in both groups. An intricate balance of all these muscles is

necessary for the proper functioning of the foot. It is generally recognized that on prolonged disuse, muscle atrophy is more marked in the intrinsic group than in the extrinsic group. At the time of the original exposure, chilling and anoxia of all tissues of the feet were probably greater than of the deeper tissues of the leg. This resulted in greater damage to the intrinsic muscles of the feet and their nerve and blood supply, than to corresponding structures higher in the leg. Thus the muscles of the foot were first weakened by direct damage and secondarily by atrophy of disuse with imbalance in favor of the long muscles. The long extensors to the 2nd, 3rd, 4th and 5th toes then pulled the metatarsophalangeal joints into a marked plantar flexion. The flexors to the great toe being stronger than the extensors resulted in a plantar contraction of that toe. The increased space between the toes was due to the swelling of the tissues, plus the fixation in contraction of the lumbrical and interosseous groups. Some degree of pes cavus is produced by the contraction of the muscular and fascial structures in the plantar aspect of the foot. The appearance of cavus is exaggerated, however, by atrophy of the plantar soft tissues and by the plantar deformity of the great toe.

These findings call attention to the importance of proper support during the acute phase following injury of the extremities and to early and continued active exercises to prevent or lessen permanent deformity.—*Mary Frances Vastine*.

ROENTGEN AND RADIUM THERAPY

CAMPBELL, PAUL A. Aerosinusitis—its cause, course, and treatment. *Ann. Otol., Rhin. & Laryng.*, June, 1944, 53, 291-302.

The great increase in aerial transport and the widespread use of low pressure chambers for the indoctrination and classification of flying personnel which has occurred during the present world conflict has focused attention upon certain conditions produced by the more or less rapid changes in barometric pressure, consequent to ascent and descent. From the viewpoint of the otorhinolaryngologist, the most important of these conditions is aero-otitis media. However, another condition, aerosinusitis, is a very definite entity and may at times be quite spectacular. In the experience of the author, aerosinusitis presents an incidence of about one-twentieth that of aero-otitis

media and occurs under similar conditions.

Definition. Aerosinusitis is an acute or chronic inflammation of one or more of the nasal accessory sinuses produced by a barometric pressure difference between the air or gas inside the sinus and that of the surrounding atmosphere. It is commonly characterized by congestion and inflammation of the lining structures. Pain over the area of the sinuses is usually present. Mucosal or submucosal hemorrhage may occur. The condition may at times result in temporary or permanent change in the mucous membranes lining the sinuses depending upon the amount of barotrauma involved.

Classification of Aerosinusitis. In the normal sinus with an unobstructed ostium, free flow of gas or air between the cavity of the sinus and outside environment brings about equilibrium during ascent and descent without change in structure and consequently without sensation. Two conditions, however, may alter or prevent this free exchange of the gaseous matter. They are, first, the presence of fluid, mucus, pus, or similar substances covering the ostium, and second, obstruction of the ostium by redundant tissue or anatomical deformity. The first instance represents the basic pathology for the development of non-obstructive aerosinusitis and the second the basic pathology for the development of obstructive aerosinusitis.

1. Non-obstructive Aerosinusitis. When there is fluid, pus, or mucus covering the ostium in such a manner that it may be pushed away by relatively small pressure changes, little happens on ascent as the flow is outward. On descent, however, the direction of flow is reversed and fluid, mucus, or pus may be pressed into the sinus. Usually this phenomenon takes place without pain or other sensation but it represents a mechanism by which an uninfected sinus under certain circumstances may become infected.

2. Obstructive Aerosinusitis. When the ostium is blocked by swollen or redundant tissues or anatomical deformity, the air or gaseous contents of the cavity are trapped and during altitudinal change produce a pressure, positive in ascent or negative in descent, relative to the environmental pressure.

Blockage during descent is the more common occurrence. Under such circumstances, the relative negative pressure (vacuum) must be compensated for and alteration in structure and contents follows. The degree of alteration depends upon the degree of pressure differential.

If the degree is minor, adequate compensation will be afforded by increased secretion of fluid to fill sufficient space to equalize the pressure and release the flutter valve if such a mechanism was the causative agent. This condition may be labeled (1) first degree obstructive aerosinusitis, and is characterized by only slight, if any, pain, and usually insufficient symptoms to come to the attention of the physician. (2) Second degree obstructive aerosinusitis could readily be the designation of the condition when characterized by localized or generalized swelling of the mucosa with exudation of the tissue fluid. This degree of involvement produces definite symptoms and findings. Pain and hyperesthesia over the sinus are present, and remain for some time (one to seven days) after descent. There is usually only slight, if any, fever or leukocytosis. Roentgenography demonstrates thickening of the lining membrane and possibly some clouding produced by fluid. (3) The most severe degree of obstructive aerosinusitis may be categorized as that of third degree aerosinusitis. The differential pressure necessary to produce such a condition must be relatively great—18,000 feet or more. The resultant picture is that of extensive swelling of the lining membranes, often accompanied by extravasation of blood into the cavity of the sinus or submucosal hematoma. Excruciating pain over and about the affected sinus is present. The sensation has been described by airmen to resemble a bee sting. Fever and leukocytosis are present. Roentgenography demonstrates thickened lining, clouding by fluid or blood, and at times, submucosal hematoma, or stripping of the lining membrane. Resolution, if complete, takes from seven to twenty-one days.

Sinuses Involved. The frontal sinus seems to be involved much more often than any of the other sinuses. Incidence of involvement of the maxillary sinuses offers a poor second. Four probable reasons may be given: (1) The length and structure of the nasal frontal duct offer much more opportunity for obstruction. (2) Large sinuses are more affected than the smaller sinuses. (3) The position of the ostium of the frontal sinus would lead one to expect occasional flutter valve action of the turbinates, and redundant or swollen tissue of the turbinates. (4) The frontal sinuses have no accessory openings.

Treatment. (1) Non-obstructive aerosinusitis in most instances responds to the simplest forms of treatment if any treatment is necessary

(2) The obstructive types present a somewhat different problem. In this instance, the primary attack must be directed toward equalizing the pressures inside and outside the cavities. The ideal treatment would seem to be a return to the altitude at which the block was formed, correcting the obstruction, and then a slow return to ground level. This can be accomplished either in a low pressure chamber or by actual flight, and has given good results in some cases.—*Mary Frances Vastine.*

KASABACH, H. H., and DONLAN, C. P. Roentgenotherapy of hemangioma of the larynx in infants. *J. Pediat.*, April, 1945, 26, 374-378.

The authors summarize the 8 previously reported cases of hemangioma of the larynx in infants and add 2 additional cases of their own. In both of their cases the diagnosis was followed by tracheotomy and external roentgen irradiation. One case was treated with 200 kv., 50 cm. target-skin distances, 0.5 mm. copper plus 1.25 mm. aluminum filter, 150 r daily dose. The second case was treated with the same factors except for 100 r as a daily dose. In each case a calculated tumor dose of 1,200-1,300 r was delivered and in each case the lesion disappeared completely.

These hemangiomas in infants are believed to be congenital and are said to be more common in males although the 2 cases reported in this article occurred in females. The lesions are usually upon or above the vocal cords in adults and are usually if not always subglottic in infants. The symptoms in order of frequency are obstructive dyspnea, inspiratory stridor, hoarse cry, croupy cough, blood-tinged mucus and gross hemorrhage.

Treatment recommended by the authors is preliminary low tracheotomy followed by roentgen therapy provided 1,200 r can be delivered to the lesion.—*R. M. Harvey.*

HARVEY, ROGER A., SPINDLER, HOWARD A., and DOWDY, ANDREW H. Roentgen therapy as an adjunct in the management of acute postpartum mastitis. *Surg., Gynec. & Obst.*, April, 1945, 80, 396-403.

This report is based upon the methods used and results obtained in treating 100 patients with roentgen therapy for acute mastitis between January, 1942, and June, 1944.

Treatment.

1. Roentgen Therapy. The initial dose of roentgen therapy used in this series of patients

varied from 40 r to 100 r and was dependent on the severity of manifestations of the disease and size of the area involved. The most acutely ill patients or those with large areas of involvement were given the small initial dose, while those with milder symptoms and smaller areas of involvement were given the larger initial dose of roentgen rays.

The number of treatments used in this series varied from one to five per breast and averaged 2.3 treatments per breast. The total dosage per breast varied from 40 r to 400 r and averaged 165 r. In general if a patient does not show satisfactory response in thirty-six to forty-eight hours, during which time two or three roentgen treatments have been given, this form of therapy should be discontinued.

Patients with superficial infection only or those with small flat breasts with superficial or deep infections, were usually treated at 120 kv. and with 3 mm. of aluminum filtration. The other patients were treated at 200 kv. and with 0.5 mm. copper and 1.0 mm. aluminum filtration.

2. Nursing. Four instances of infant diarrhea, 2 of infant stomatitis, and 1 of infant parotitis were noted shortly after the appearance of maternal mastitis in this group of patients. For this reason it is preferred that the baby not nurse from the infected breast during the acute phase of the disease. Nursing is usually interrupted from the infected breast for six to eighteen hours. If the patient does not show marked constitutional reactions, it is safe to continue nursing from the uninvolved breast.

3. Pumping the Breast. The authors delay the use of a breast pump in patients with primary areolar or periareolar infection because of the massaging action which such an area receives during the pumping procedures.

4. Drying up Lactation. Any infection which cannot be cleared in forty-eight hours so seriously interferes with the infant feeding routine that function should be terminated in both breasts.

5. Breast Binders. All patients are markedly relieved when support is furnished to the breast to prevent any motion of the inflamed area.

6. Ice Packs. Ice has an immediate numbing effect on the painful area and decreases the blood flow to the involved area with resultant decrease in absorption of toxins into the general circulation.

7. Heat. In the early stages of mastitis, local heat makes the patient much more uncomfortable.

8. Fluids. No attempt is made to limit fluid intake during the course of the acute infection, even if the breasts are being dried up at the time.

9. Sedation. Threshold tolerance for pain is so variable that no routine is maintained in this aspect of treatment. Salicylates are frequently prescribed, and combined with codeine only in extreme situations.

Summary and Conclusions

1. Roentgen therapy combined with rational symptomatic treatment of 137 breasts affected by acute postpartum mastitis resulted in 2 abscesses, 1.5 per cent, as compared with 20 per cent abscesses with other methods of treatment in use prior to this series. The 2 abscesses in the roentgen treated group occurred in patients initially treated by other methods and not referred for roentgen therapy until four and seven days after onset of the disease.

2. The duration of subjective symptoms in these patients was reduced from an average of eight days with methods of treatment other than roentgen therapy to an average of 1.8 days with roentgen therapy.

3. Application of roentgen therapy is so effective in the early stages of this disease that treatment should be started as soon as the diagnosis can be definitely made, regardless of the hour. Delay in starting this treatment decreases chances of recovery without surgery.

—*Mary Frances Vastine.*

HERGER, CHARLES C., and SAUER, HANS R. Androgen control therapy in 130 cases of carcinoma of the prostate. *Surg., Gynec. & Obst.*, Feb., 1945, 80, 128-138.

It is the purpose of this paper to analyze the results of endrogen control treatment in 130 patients with prostatic carcinoma. Seventy-nine of these cases were followed up for one to two and a half years; 27 of the remaining 51 patients were following for a period of from four to twelve months and 24 died of the disease (16) or of other causes (8) within the first year after beginning treatment.

Analysis of Study.

1. Favorable response to this method of treatment of prostatic cancer was accomplished in numerous instances. However, during the course of prolonged observation, it became evident that a considerable number of the group of patients showing initial improvement

developed into delayed failures. Thus, the conclusion is that even the most spectacular improvement in any patient has to be viewed with skepticism as to the ultimate outcome.

2. In the treatment of patients with far advanced or metastatic disease, androgen control treatment has proved its value as a method to prolong life. The degree of response to this method of treatment is much more impressive as a rule when the poor results accomplished by external or interstitial irradiation.

3. The results obtained were most favorable in the group of patients with metastatic lymph node involvement. All but one of the patients with metastatic lymph node involvement responded with complete regression of the metastases and so far, none of them has developed recurrence.

4. In contrast, it has been the authors' experience that spread or local extension of bone metastases is not arrested as a rule by androgen control treatment. Also this method of treatment does not protect the patient with non-metastatic cancer of the prostate from developing metastases at a future time.

5. In spite of the apparent ineffectiveness of androgen control therapy on bone metastases proper, it cannot be denied that many of these patients derive temporary benefit from this method of treatment, such as disappearance or improvement of pain, gain in weight, and increase in well-being.

6. The authors are in agreement with Nesbit and Cummings, who express the opinion "that the maximum benefit to the patient maybe derived by delaying endocrine therapy until indicated by the onset of symptoms arising from the advanced or metastatic lesions."

7. Castration should be reserved for patients with metastatic disease, patients in whom metastases are suspected, or patients in whom rapid enlargement of the primary lesion becomes apparent. It is the authors' impression that castration is the more effective procedure if quick relief from pain in the object of therapy. Combined treatment consisting in orchidectomy preceded or followed by estrogen administration does not seem to offer any advantage over castration alone.

8. Exclusive stilbestrol medication should have its place in selected cases of prostatic cancer: (1) in patients with operable carcinoma of the prostate who refuse surgery; (2) in patients who refuse orchidectomy and (3) in patients with moderately advanced lesions of

apparently low grade malignancy who have few or no symptoms.

9. Failures which occur following exclusive stilbestrol administration may be improved, at least temporarily, by orchidectomy, while estrogen administered in cases of failures following castration is ineffective as a rule. It has been suggested by Huggins that castration or estrogen administration results in a reduction in the quantity and activity of circulating androgens, thereby causing decrease in size and function of the cancer cells. He also believes that immediate or delayed failures of androgen control therapy are due to the presence of extragonadal foci of androgen production, notably in the adrenal cortex.

10. With this idea of Huggins' in mind, the authors have given external roentgen irradiation to the pituitary in 23 patients (200 kv. and delivering a total of from 1,000 to 1,700 roentgens into the region of the sella turcica). Conclusions from this treatment are that irradiation of the pituitary produced neither an appreciable decrease in the serum acid phosphatase activity, nor increase in the patient's weight nor improvement in the appearance of metastatic bone lesions. However, some degree of palliation seemed to be accomplished in that the rapid retrogressive course in delayed failure patients was slowed down at least temporarily in some of the cases treated.

11. Radiation therapy of the pituitary is not a substitute for castration or estrogen administration.—*Mary Frances Vastine.*

ABEL, STUART. Androgenic therapy in malignant disease of the female genitalia; preliminary report. *Am. J. Obst. & Gynec.*, March, 1945, 49, 327-342.

In an extensive laboratory study of gonad hormones in 1932, Moore and Price postulated their conception of hormone interactions to include four principles: (1) gonad hormones stimulate homologous accessories; (2) secretions produced by the pituitary stimulate the gonads to function both in germ cell production and in hormone secretion; (3) gonad hormones have no *direct* effect on the gonads of either the same or the opposite sex; (4) gonad hormones of either sex exert a depressing effect upon the pituitary which results in a diminished amount of the sex-stimulating factor available to the organism.

A series of patients with previously treated but progressively advancing malignancies of the female genitalia have been given testo-

sterone propionate in arbitrary dosage of 140 to 150 mg. weekly. This was done because in the light of laboratory and clinical studies, an investigation of the possible value of male hormone in the treatment of malignancies of the female genital tract seemed highly warranted. If by the administration of testosterone the depressing effect on the pituitary would diminish the amount of sex-stimulating hormone, and if such administration is without effect upon the heterologous secondary female organs, it seemed not unreasonable to relieve that retardation, even possible regression of the malignant growth might occur in a manner comparable to the effect of estrogens on prostatic growths.

Cases to which testosterone propionate was given included carcinomas of the breast, ovary, fallopian tube, uterine corpus and cervix. A preliminary report of 5 cases in detail including carcinomas of the uterine corpus and cervix is presented. These patients have been receiving treatment for ten months.

Conclusions. All of these patients showed striking improvement in morale with feeling of well-being bordering at times on euphoria.

There was definite improvement of menopausal symptoms such as nervousness, insomnia, headache, depression, and, in most cases, hot flashes.

Increased libido was consistent and marked.

With the arbitrary dosage used (140 to 150 mg. per week) masculinizing symptoms appeared in all patients and included hypertrophy of the clitoris, development of a beard, and voice change. Acneiform eruptions occurred in 3 of the original 5 patients and in many of the subsequent cases.

Vaginal smears tended toward the atrophic state and changed little during treatment.

To date, there has been nothing to indicate any regression or even retardation of the malignant process in manner comparable to the effect obtained in estrogenic treatment of prostatic carcinomas. In one of the original patients and in two subsequent cases, metastatic lesions were seen to progress during the course of treatment.—*Mary Frances Vastine.*

CANTRIL, SIMEON T., and BUSCHKE, FRANZ.

Roentgen therapy in gas bacillus infection. *Radiology*, Oct., 1944, 43, 333-345.

Nine cases of gas bacillus infection treated with surgery and roentgen irradiation are described and illustrated with photographs,

roentgenograms and fever charts. A table shows the details of treatment and results; the roentgen treatment varies as greatly from case to case as does the surgical treatment. This includes all the cases of gas bacillus infection which the authors have treated by roentgen irradiation. In all except 2 cases there was bacteriologic proof that the infection was caused by a gas-producing organism. There was no mortality but this record could probably not be maintained in a large series of cases. However Kelly reports a mortality of only 11.2 per cent in 125 cases which is much better than the record with any other form of treatment.

Gas bacillus antitoxin was given in 4 cases; the authors believe that these patients would have recovered as well without it. This opinion is supported by Kelly's statistics who had a mortality of 35 to 50 per cent in cases treated with serum therapy and surgery and of 4.3 per cent in cases treated with surgery and roentgen irradiation without serum. Nor did the cases in which sulfonamides were given offer any evidence that chemotherapy played any part in controlling the progression of the gas bacillus infection.

It is believed that a thoughtful combination of roentgen treatment and surgery will give better results than any other known treatment of this disease.—*Audrey G. Morgan.*

SIGEL, HARRY. Direct current combined with x-ray therapy; case of Kaposi sarcoma thus treated. *Radiology*, Oct., 1944, 43, 386-390.

The author reports a case in which he used the direct current in combination with roentgen treatment to increase the effectiveness of the latter. The patient was a man of sixty-seven admitted because of edema of the left leg and the bluish tumors characteristic of hemorrhagic sarcoma on various parts of the body.

The roentgen treatment was given with 120 kv., 5 ma., 4 mm. aluminum filter and 25 cm. distance with an output of 15 r per minute. Each area was given a total of 1,500 r. For the electrical treatment the positive electrode, large enough to cover the whole tumor area, was placed over the tumor and the negative electrode over a nearby area so that the lines of force would travel as directly as possible through the tumor and produce the greatest possible current density at the site of the tumor. Direct current was given first for about ten minutes, then roentgen irradiation begun while the current was still on and both con-

tinued until the desired roentgen-ray dose had been given. Two areas on the arm were selected and one given the combined treatment and the other roentgen treatment alone. Though these tumors are radiosensitive it was possible to detect a markedly better response to the combined treatment than to the roentgen treatment alone.—*Audrey G. Morgan.*

SIDDALL, R. S. Carcinoma of the vaginal wall in a girl of fourteen; radiation therapy. *Harper Hosp. Bull.*, Dec., 1944, 2, 54-56.

A girl came for treatment May 9, 1942, two weeks before her fourteenth birthday. She had had hemorrhage at approximately regular periods for eighteen months which was thought to be menstruation, but recently the bleeding had become almost continuous. Examination showed a soft irregular mass in the region of the cervix; a small piece of tissue examined microscopically showed advanced medullary squamous cell carcinoma but examination under general anesthesia showed that the growth was on the anterior and right lateral walls of the vagina and did not involve the cervix.

On May 22, 1942, 100 mg. radium in suitable containers and screened with 1 mm. brass and 1 mm. hard rubber was placed in the vagina opposite the tumor; the dose was 3,600 mg-hr. From May 25 to 28 supervoltage roentgen therapy was given externally. Anterior and posterior fields were used, cross-firing the pelvis. The quality of the rays was that obtained with 500 kv., and a filter of 7 mm. copper, 3 mm. aluminum and 3 mm. celluloid. The total dose per field was 600 r in air. A second series of roentgen therapy with the same technique was given from August 14 to 18, 1942, and on October 15, 50 mg. radium was applied to a total dose of 1,800 mg-hr.

The tumor disappeared in three months after the first two series of treatments. But two months later it recurred and on the third series of treatments it again disappeared. On October 25, 1944, there was still no sign of recurrence but the time is too short to pronounce it a permanent cure.

The vagina contracted so that the finger can only be introduced for about 6 cm. In spite of the heavy irradiation pubic hair and other secondary sexual characteristics have appeared. There has been no sign of menstruation since early in the treatment.—*Audrey G. Morgan.*

KOBAK, ALFRED J., FITZFERALD, J. E., FRED, VINCENT C., and RUDOLPH, LOUIS. Carcinoma of the cervix and pregnancy. *Am. J. Obst. & Gynec.*, March, 1945, 49, 307-326.

In the past five years, the authors have observed 8 cases of carcinoma of the cervix occurring during pregnancy on the obstetric services of Cook County Hospital. These cases were thoroughly studied clinically.

Summary and Conclusions.

1. The uneven distribution of these cases whereby 6 were noted in one year would render untenable a statistical evaluation of its incidence.

2. Many white and negro patients are seen annually in this hospital and it appears that carcinoma of the cervix, at least during pregnancy, might be more frequent in white women.

3. In 7 patients the malignancy was a stratified squamous cell carcinoma and in 1 patient, who died undelivered it was an adenocarcinoma.

4. There is a tendency to regard carcinoma of the cervix during pregnancy as so improbable that other causes of bleeding are given stubborn precedence in diagnosis and therapy. The malignancy is thus diagnosed more often toward the end of pregnancy, when the growth has achieved large proportions.

5. Carcinoma of the cervix, contrary to the opinion of several contributors, continues to develop at a rapid pace during pregnancy. The earlier the diagnosis is established the sooner effective therapy may be instituted, and the better the ultimate prognosis.

6. The treatment of these cases depends upon the disposition of the pregnancy. In the first trimester the pregnancy is disregarded and deep roentgen therapy is instituted. With the death of the fetus, radium is added to the treatment. In advanced pregnancy, there is added concern for the cervix. The latter should be spared of the injuries that occur during parturition. If there is no infection as noted by the temperature or character of the vaginal discharge, a classical cesarean section is performed to spare the cervix of trauma and to leave intact the fundal portion of the uterus to facilitate the radium therapy, which is started after uterine involution has occurred. A total of 4,500 mg-hr. of radium is given in three equally divided doses. As soon after the delivery of the baby as possible, deep roentgen treatments are started,

and continued for a long period of time. In the presence of local infection by criteria mentioned, a Porro cesarean section is preferred. In pregnancies close to viability the cesarean section may be deferred, and 1,500 to 3,000 mg-hr. of radium may be given to the cervix to temporarily inhibit the progress of the new growth.

7. The ultimate prognosis for the patient hinges on the persistent continuation of the deep roentgen and radium therapy that is instituted after the disposition of the pregnancy. —*Mary Frances Vastine.*

MISCELLANEOUS

ZINTHEO, CLARENCE J., JR. Simple fluoroscopic method of foreign body localization. *Radiology*, Oct., 1944, 43, 376-377.

Most methods of roentgenoscopic localization of foreign bodies require special apparatus or attachments of some preliminary calibration. A method is described and illustrated which can be carried out simply using only the materials ordinarily at hand in any laboratory and without any calibration. It consists essentially of locating with the movable blade of a caliper a point alongside the patient which is in the same horizontal plane as the foreign body; it is based on the fact that shadows of objects in the same plane are displaced to an equal extent when the fluoroscope is moved. An accuracy of 1 cm. or even 0.5 cm. can be achieved easily. Directions are given for protecting examiner and patient from undue exposure to the rays and the necessity for such protection is emphasized. —*Audrey G. Morgan.*

SPEAR, F. G. The action of neutrons on bacteria. *Brit. J. Radiol.*, Nov., 1944, 17, 348-351.

Experiments are described which were made to determine the lethal action of a neutron beam on colon bacilli and on spores of *Bacillus mesentericus* when they were exposed to gradually increasing doses of radiation and to compare the results with those obtained with other types of radiation. The work was done with Lawrence's 37-inch cyclotron at the Radiation Laboratory, Berkeley, California. A diagram is given showing the position of the bacterial suspensions 7.0 cm. from the target of the cyclotron and two tables, the first showing the complete details of a single experiment and the second a summary of all the experimental results.

An n-unit was used for measuring the neutron radiation; it is the neutron dose given when the Victoreen dose meter, calibrated for x-rays records roentgen. Survival curves are given for the cultures of bacteria which are exponential in form. A tentative comparison between the effects of roentgen, gamma and neutron irradiation may be obtained by determining the dose required to produce a 5 per cent lethal action and expressing the result as an r/n ratio, r being the measurement of x or gamma radiation in roentgens and n that of the neutron dose in the author's unit. The r/n ratio for colon bacilli is 3.2 and that for *Bacillus mesentericus* 5.3. The r/n ratio shows wide variation according to the material irradiated. It varies from 1 to 10 with a value of 5 to 6 in most experiments. Until the dosimetry of neutrons has been studied more completely, however, the values of the ratio must be considered provisional. It must not be assumed, however, that for equal energy absorption neutrons produce a greater effect than roentgen or gamma irradiation. It seems probable that the energy absorbed per unit volume of tissue exposed to 1 n of neutrons is about the same as that from 2.5 r of gamma irradiation. —*Audrey G. Morgan.*

SPEAR, F. G., and TANSLEY, KATHARINE. The action of neutrons on the developing rat retina. *Brit. J. Radiol.*, Dec., 1944, 17, 374-379.

It has been found that degeneration in tissues irradiated with roentgen and radium rays depends on mitotic activity. The experiments here described were made to determine whether neutron irradiation at doses which permit ultimate recovery of the tissues has the same biological effect.

The irradiations were given with the cyclotron on immature rat retinas. The technique is described. A table is given showing the mitotic phase and degenerate cell counts after each dose of neutron and a similar table is given for radium irradiation. Degenerate cells appeared after one to three hours. In all the experiments this initial decrease was followed by a renewal of mitosis and with doses above 5 n this return of mitosis was characterized by a marked distortion of the phase ratio. (Doses from 2.5 n to 60 n were used.)

As the dose is increased to 60 n the initial decrease of mitosis increases and recovery is more delayed. Some recovery follows the initial

fall of mitotic rate caused by neutron irradiation but the increase to a supernormal level seen with roentgen and radium irradiation does not occur after a dose of more than 2.5 n. Up to 15 n there is an increase in the prophase count but not in the metaphase and telaphase counts.

It seems that the mitotic curves after neutron irradiation do not differ materially from those after roentgen and radium irradiation but the effect on cell degeneration is much more marked. The degenerate cell count on neutron irradiation is made up partly of cells killed outright and partly of cells that are injured and die later when they attempt mitosis. The curve of cell degeneration which accompanies increased dosage occurs much sooner and is markedly steeper than with radium. The curves given show that roughly neutrons are 2.6 times as effective as radium rays per unit energy and 6.5 times as active per n unit.—*Audrey G. Morgan.*

HALBERSTAEDTER, L. Effects of x-rays on erythrocytes irradiated in vitro. *Nature*, June 3, 1944, 153, 683.

The author, working in the Cancer Laboratories of the Hebrew University, Jerusalem, found that irradiation of erythrocytes in vitro with roentgen rays causes hemolysis. But if a dose of 2,000,000 r is given to an erythrocyte concentration of 0.1 per cent or less in normal saline a state of resistance to hemolysis develops.

In this article experiments are described which were made to determine whether the erythrocytes rendered resistant to roentgen rays in this way are also resistant to other hemolysins such as sunlight and saponin. Human or rabbit erythrocytes were irradiated with 2,000,000 r and after twenty-four hours there was no hemolysis. After addition of eosin to the irradiated drops and non-irradiated control drops they were exposed to sunlight. Hemolysis occurred in the control drops after ten to twenty minutes but no hemolysis took place in the irradiated drops after one to two hours. Similar irradiated and control drops were treated with different concentrations of saponin; hemolysis took place in the control

drops after about five minutes in a 1:15,000 saponin solution while none took place in the irradiated drops after twenty-four hours in a solution of 1:3000 saponin.

These experiments show that exposure to roentgen rays may cause complete hemolysis of erythrocytes or may render them resistant to the hemolytic action of roentgen rays, sunlight or saponin. Which effect takes place depends on the concentration of erythrocytes in saline solution and the dosage of roentgen rays. Resistance to hemolysis does not occur if serum is added to the normal saline or if the erythrocytes are irradiated in glucose solution.—*Audrey G. Morgan.*

BISGARD, J. DEWEY, HUNT, HOWARD B., and DICKINSON, R. HUGH. Effect of x-ray irradiation upon bacterial toxemia in rabbits. *Radiology*, Oct., 1944, 43, 330-332.

Previous experiments have shown that irradiation of the abdomen in rabbits produces nonspecific antitoxin. The experiments described in this article were made to determine whether the same effect is produced by irradiation of other parts of the body. One-half the animals were irradiated over the chest and the other half over the extremities at 140 kv., 15 ma, target-skin distance, 50 cm., an inherent filter of 3 mm. aluminum and an added filter of 0.5 mm. copper and 1 mm. aluminum. It was found that antitoxin is produced no matter what part of the body is irradiated.

Further experiments showed that 20 r is the approximate minimal effective dose for rabbits and this dose appeared to produce as much antitoxin as larger doses.

Injections of serum and plasma afforded some degree of protection against *E. coli* toxin, but normal non-irradiated serum and plasma was as effective as that that had been irradiated. It is probable that the effect was due to the simple addition of the antitoxin contained in the blood and plasma to that already in the tissues of the animals. Apparently the antitoxin demonstrable in the plasma after irradiation is produced by tissues other than the blood.—*Audrey G. Morgan.*



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RADIOLOGY IN THE ATOMIC AGE*

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INDIANAPOLIS, INDIANA

MY FIRST words will be to thank you, Members of the American Roentgen Ray Society, for the honor bestowed upon me and to let you know how deeply I appreciate the distinction which this Society has conferred upon me. In the past this office has been held by leaders in American radiology who are responsible for the place our specialty holds in the radiology of the world. Many original contributions, usually presented first at the annual meeting of this Society, have come from these men. Hence it is with considerable apprehension that I assume the office with which you have honored me and offer a few remarks on the subject of "Radiology in the Atomic Age."

As Year One of the Atomic Age ends and Year Two begins it would seem reasonable to think that certain radiologists actually connected with the gigantic project of releasing atomic energy could best discuss this topic with us. But such is not the case due primarily to continued security restrictions upon these authorities and to the preoccupation of most of them with the data from the recent scientific tests at Bikini Atoll. However, one need not be a member of the Manhattan Engineer Dis-

trict Project nor of the select group of investigators at Bikini to appraise the effect of the first atomic explosion upon our specialty and to venture a short extrapolation into the near future.

The element uranium, which was to prove itself to be the "philosopher's stone" for the large scale transmutation of the elements in the 20th century, was discovered by Klaproth in 1789. It was 107 years later that the most important property of this element, namely, natural radioactivity, was determined, for it is characteristic of science that discoveries are rarely made except when people's minds are ready for them. After the discovery of the x-ray by Röntgen in 1895 every laboratory in the world took out its old Crookes tubes to produce roentgen rays. These tubes showed that the production of roentgen rays had the power of producing brilliant phosphorescence in the glass envelope of the tube and as roentgen rays appeared to emanate from these points of phosphorescence it was certain that some investigator would wonder if roentgen rays and phosphorescence were not in some way interrelated and attempt to produce darkening of a photographic

* President's Address delivered before the Forty-seventh Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 17-20, 1946.

plate by various phosphorescent substances. Thus it was that Henri Becquerel in February, 1896, discovered the natural radioactivity of uranium. His collaborators on the problem of determining the substance or substances in the uranium salts responsible for the emission of the radiation were Pierre and Marie Curie. Their laborious chemical analyses and fractional distillations finally culminated in the separation of two new elements, polonium and radium, and established the factual evidence and foundation for modern atomic physics.

There followed revolutionary years of experimental and theoretical advances by Rutherford, Einstein, the Joliot-Curies, Bohr, Chadwick, and the Americans, Urey and E. O. Lawrence. Half a century has passed since the Curies set off on the road which has led to the present discoveries, and so enormous is our modern technology that in the same length of time (five years) required for the Curies to extract a minute amount of pure radium from several tons of pitchblende the gigantic physical and engineering prowess of American industries, universities and laboratories has made atomic power available for war and peace.

Whatever direction the large-scale development and utilization of atomic energy takes it will influence medicine profoundly. As our mastery of atomic techniques develops, and the tremendous amount of research being carried out in the whole field of radioactivity finds wider clinical application, it is to the radiologist to whom members of the other medical specialties will turn for information.

The first point that I propose to discuss is the closer relationship that will exist between the radiologic physicist and the radiologist in the Atomic Age. Physics has now a more important part to play than ever before in medical research and even in the *daily treatment of the patient*. The collaboration of radiologist and radiologic physicist becomes now the *sine qua non* for correct and intelligent therapy with the

new radioactive isotopes. An atomic pile in operation is a source of radioactive materials, many of which will be medically useful, far greater than any source previously known. As a direct result of the fission process of the uranium itself there are produced radioactive isotopes of elements located in the middle part of the periodic system of the elements. These radioactive substances can be purified chemically and used medically. In addition, an atomic pile is far more efficient in bombarding substances with neutrons than is a cyclotron, and as a result most elements can now be obtained in a radioactive form in far greater quantity than heretofore dreamed of. Since the radiations emitted by them are equivalent to the radiations emitted by radium, these substances will be used for medical purposes on a much greater scale than has been possible with radium. So if our reliance on the radiologic physicist has been great for the proper knowledge and physical data in the correct and intelligent utilization of radium how much greater will be our cooperation and alliance with the physicist in the Atomic Age! Mayneord,¹ writing on "Physics in Medicine" in a recent issue of the *British Medical Bulletin*, states the situation as follows: "The physicist must realize that however fascinating and important his more academic problems, his primary responsibility is to be useful, while on the part of the radiologist we ask for a more enlightened understanding of the importance of the physicist, not only in solving the technical day-to-day problems but also as a spearhead of the attack on the fundamental biophysical problems of the structure of living material and its interaction with radiation."

To the faithful physicists, who as Associate Members of this Society have done so much to advance the physical foundations of radiology in this country, and through their service on the American Board of Radiology have painstakingly and laboriously raised the standards of the certified radiologists will fall the bulk of

the burdensome task of directing and guiding the medical application of each of the useful radioactive isotopes by the same thorough and time-consuming work that was required for radium dosage.

Another important consequence of atomic power development of the future will certainly be the health problems of such an industry, and the industrial hazards to health will be primarily radiological. By the very nature of things the industrial medicine of the atomic age will be radiological. In the development of methods of using atomic energy for military purposes the importance of health problems was early apparent and a health division of the atomic bomb project was organized under our colleague, Dr. Robert S. Stone. Medical men and radiologists, in particular, are extremely anxious to learn the results and detailed knowledge obtained by our colleagues, Dr. Stone, Dr. S. L. Warren, and a host of other investigators, in the work on this phase of the project. It seems we shall not learn of it fully at first-hand until that portion of the science involved in the beneficial uses of atomic energy can be divorced from the technology involved in making atomic weapons.

We do know, however, that work carried on by them was along three lines of inquiry: (1) provision of instruments and clinical tests to detect any evidence of dangerous exposure of the personnel; (2) research on the effects of radiation on persons, instruments, etc.; and (3) estimates of what shielding and safety measures must be incorporated in the design and plan of operation of the atomic energy plant. The important data collected in these three fields is certain to form the foundation of the radiological industrial medicine of the future. In the very near future, no doubt, the radiologist will have available for his use specialized detection equipment sufficiently reliable to permit its being correctly and successfully operated by technicians and others having little experience in the complexities of the electronic circuits involved. Professor Robley D. Evans re-

cently wrote, "It should be possible to bring these instruments to nearly the same state of universal usefulness as a household radio." Thus a whole new branch of industrial medicine will open up for the certified radiologist, with him and his technicians operating in addition to the regular radiological equipment the many newly devised specialized types of detection devices and Geiger-Müller counters. The future developments in this field of occupational medicine, which I have called radiologic industrial medicine, will parallel, of course, the development and use of atomic energy for the production of controlled and usable power, and may not lie so remotely in the future as the time interval between the discovery of the x-ray and the construction of the modern Coolidge tube.

Another phase of our specialty destined to be greatly affected by the developments of the Atomic Age is that branch often spoken of as radiologic jurisprudence. A new cause of litigation arises out of the hazard incurred by personnel working with or near atomic piles, cyclotrons and their radioactive products. The two types of radiation hazard connected with an atomic pile or with a cyclotron are neutrons generated in the pile or during cyclotron bombardment and alpha particles, beta particles and gamma rays emitted by the radioactive products of a pile or cyclotron. Considering also that the amount of radioactive material to be handled, much of it by technical assistants of non-professional standing, is many times greater than has ever been encountered before, one can quickly realize the great expansion of medicolegal problems accompanying radiology in the Atomic Age.

Should the world be stupid enough to launch an atomic war, which would surely be the most deadly in history, what would be the military medicine of such a war? We can say it would be radiologic military medicine in that by far the greatest percentage of killed and wounded would be radiological casualties caused by the power-

ful and intense radiations of all types, and, perhaps, the medicomilitary measures against poison gas (anti-gas impregnated clothing and the gas mask) would be replaced in the atomic war by the inverse square law, lead and concrete protective devices and Geiger counters. But what do we or the Surgeon General know about the pathological physiology and treatment of radiation sickness and injury for those persons not killed outright but suffering from overwhelming or even moderate over-exposure to radiation? Yes, military medicine in the atomic age will be radiological, but virtually hopeless and futile. There can be no medical service, no organized medical relief such as we prided ourselves in during World War II, for the medical service, the medical personnel, and the medical supplies for relief of misery are all vaporized in the holocaust.

Before the curtain of military security descended on the science of nuclear physics in America Dr. John H. Lawrence² delivered the Caldwell Lecture in this same auditorium in 1941 on the subject, "The New Nuclear Physics and Medicine," and showed the high promise held for many radioactive isotopes in cancer therapy and biochemical tracer techniques. His experiments had been carried out with radioactive atoms obtained from the cyclotron of his brother, Dr. E. O. Lawrence, at the University of California. Today the uranium pile is a far greater source of radioactive isotopes and this broad field for future research will now go forward much more rapidly. The lengthy symposium on this subject to be presented at the present meeting of our Society indicates the rapid strides already made since Dr. Lawrence's lecture. It is precisely this field where the teamwork of the physicist and those radiologists whose breadth of knowledge fits them for the task will offer most in the cooperative research work of the present and future.

However, it seems to me that a word of caution is in order against over-optimism concerning these new forms of radiation

therapy. It is very easy for the lay public, and the medical profession as well, to be over-enthusiastic and over-optimistic at the present time because of the close association of radioactive isotope research with atomic energy development in the lay press and in the current popular science writings. The history of the therapeutic use of roentgen rays and radium is full of examples of over-optimism. Our distinguished colleague and fellow member of this Society, Dr. W. Edward Chamberlain,³ expressed this idea exactly in a recent forum in which he participated. He said, "In the past we have been told too many times that this or that new and different (but not fundamentally different) source of radiation would revolutionize cancer therapy. There is no reason for believing, or hoping that these new methods of applying atomic energy therapeutically will provide a final answer to the cancer problem. . . . Cancer has been cured by irradiation in many thousands of cases and the percentage of such good results has increased steadily throughout the years. This improvement has been due in small part to improvement in equipment, in large part to increased knowledge and skill of the radiologist. These newer methods of releasing and applying atomic energy will doubtless prove of real value. The point is that we must not jump to the unwarranted conclusion that a revolutionary method has suddenly come to hand—one that will solve, or greatly modify, the problem of cancer." Many will recall the pre-war work on the therapeutic effects of direct neutron bombardment of cancer, and realize that much more clinical work is needed to fully evaluate neutron therapy. Neutron therapy and radioactive isotope therapy are gigantic problems yet to be solved after the interruptions of war.

Radiology in the Atomic Age will be greatly influenced by the vast post-war technological developments in another field of atomic research—electronics. The atom is also the home of the electron. Already the Morgan-Hodges photoelectric timer has

earned a valuable place in mass roentgenography and will soon find wide use in general roentgenography. Within the next few years many investigators will be studying the problem of amplifying the roentgenoscopic image several thousand times. Think of the unlimited possibilities of roentgenoscopy to which has been added a system of electronic amplification! With the illumination of the fluorescent screen approaching that of the roentgenographic viewbox in brightness, dark adaptation of the operator would be eliminated; examinations could be conducted in normally lighted rooms, the radiologist's office, the surgical amphitheater, etc.; the amplification would permit considerable reduction in the intensity of the roentgenoscopic exposure and markedly reduce radiation hazards. Also when the brightness levels in clinical roentgenoscopy become one hundred times their present value the stereo-roentgenoscope will become practical and useful. The field of electron optics may make all this possible for radiology in the Atomic Age.

The construction and rapid development of the induction electron accelerator—the betatron—has opened whole new fields of study in the problems of supervoltage. At present there seems to be little or no limit to the energies which the electrons may attain in the Kerst betatron, and roentgen rays can be generated by its use which surpass anything known. Almost overnight the pre-war supervoltage range of 400 kilovolts and 1000 kilovolts with conventional roentgen tubes was exceeded,

and papers are now appearing in our journals on the biological action of 20 million volt rays, doubtless soon to be followed by similar studies with 100 million volt roentgen rays. Will the betatron become part of the essential equipment of the radiologist in the Atomic Age?

Modern physical science, now a major cornerstone of radiology, has had a thousand almost unbelievable triumphs since the close of the last century. It has unlimited potentialities for helping man be man's best friend, and terrifying possibilities for helping man be his own worst enemy.

If the Atomic Age proves to be not one of mutual destruction of nations but a peaceful Age—and God grant that it will be—the frontiers of radiology will be advanced immeasurably. The precious time lost through the stupidities of war will be made up, and our specialty may well surpass the achievements of its first half century.

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REFERENCES

1. MAYNEORD, W. V. Physics in medicine. *Brit. Med. Bull.*, 1945, 3, 129-132.
2. LAWRENCE, J. H. The new nuclear physics and medicine. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1942, 48, 283-301.
3. CHAMBERLAIN, W. E. The Future of Atomic Energy: "The Biological Phase," George Westinghouse Centennial Forum, Pittsburgh, Pa., May 16, 1946.
4. MORGAN, R. H. Electronics and post-war radiology. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 52, 432-434.



SOME OBSERVATIONS CONCERNING EWING'S TUMOR SEEN IN AN ARMY GENERAL HOSPITAL*

By MAJOR GILBERT W. HEUBLEIN, MAJOR SYLVAN E. MOOLTEN, and
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CHARACTERIZATION OF EWING'S TUMOR WITH ATTEMPT AT INTERPRETATION

AN EXCELLENT summary of the clinical and pathological manifestations of Ewing's sarcoma is that given by Kolodny⁹ in 1927. This tumor is found most commonly in the small bones of the extremities, in the skull and shafts of long bones, differing in these respects from osteogenic sarcoma. In many instances the origin appears to be multiple, although this may be the result of the tendency of the tumor



FIG. 1. Ewing's tumor, showing typical uniform small cell and its characteristic relation to blood vessels.

to become rapidly disseminated. As the tumor spreads through the haversian system, the cancellous bone is involved and the architecture disintegrates, so that tension and pressure lamellae are separated and compressed, and bone appears thicker in places. As the tumor approaches the cortex of the long bone, the latter becomes rarefied. In the more slowly growing tumors a secondary or tertiary shell of new periosteal bone is formed before the tumor

perforates the periosteum, producing the appearance of laminae. More often the tumor advances too rapidly for periosteal reaction and undergoes necrosis and liquefaction resulting in a subperiosteal cavity filled with degenerated tissue resembling "pus." The consistency of the tumor depends on the stage of growth and presence or absence of regressive changes. At first it is soft, mushy, grayish white, and has the appearance of granulation tissue. This may easily mislead the surgeon into the belief that he is dealing with osteomyelitis. Later a soft, crumbly, marrowy growth is seen with connective tissue strands and frequent necrosis and liquefaction, producing the appearance of pus. Areas of yellowish cystic degeneration are found.

Histopathologically the tumor is characteristic (Fig. 1). The cell type is small, polyhedral and possesses little cytoplasm. The nucleus is round or oval. The appearance of pleomorphism is lacking and, even in the presence of abundant mitoses, tumor giant cells are not seen, in contrast to osteogenic sarcoma. The cells are extremely uniform and often form pavement sheets without organization. Not infrequently cells exhibit mucoid or hydropic degeneration. In many instances the cells are arranged around blood vessels, but this is not invariable and occurs also in other cellular sarcomas. Perhaps the most characteristic feature is the apparent complete absence of intercellular substance. As a result the cytoplasm of individual cells appears often to form a syncytium.

This tumor produces diffuse bone absorption and in its invasion of the surrounding soft parts causes corresponding shrinkage and atrophy of skeletal muscle fibers (Fig. 2). As a result the endomysium and

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perimysium become condensed into a trabeculated network acting as a framework for the growth of the tumor. In the presence of lymphocytic and plasma cell infiltration, the appearance is often very confusing and difficult to distinguish from that of a pure inflammation. The tumor spreads through the blood and lymph, especially the latter, and not infrequently involves the regional lymph nodes, but is most commonly characterized by involvement of all bones of the skeleton, especially the skull, again in contrast to osteogenic sarcoma.¹² The most frequent involvement

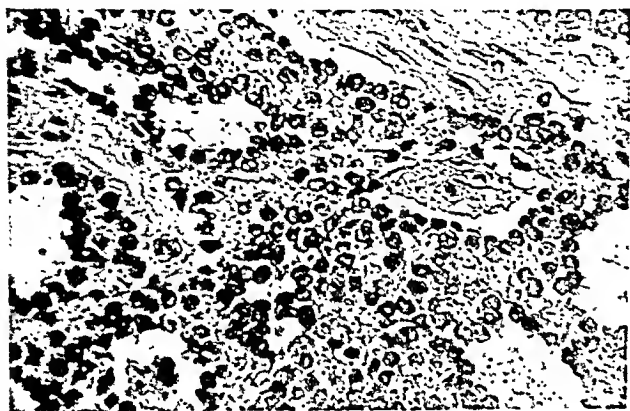


FIG. 2. Note tendency for the tumor cells of Ewing's sarcoma to creep along the perimysial framework of the overlying muscles bringing about atrophy of its fibers.

at autopsy is the lungs and skull. Metastases are histopathologically identical with the primary focus and behave in the same manner (Fig. 3). Ingrowth toward the dura may often produce pressure symptoms upon the brain, and epileptiform convulsions are not infrequent. Tumor cells may be demonstrated in the cerebrospinal fluid (Fig. 4).

Etiological factors include a decided sex predilection, about 3 cases out of 4 occurring in males, most often between the ages of five and fifteen. Occasionally the subjects manifest mild endocrinopathic disturbances, e.g. obesity or slim graceful bony structures.

The location of the tumor is most common in the "pipe" bones, especially the tibia, fibula, humerus, ulna or femur in approximately that order. Occasionally



FIG. 3. Vertebral metastasis, showing solid sheets of tumor cells closely massed, with no apparent organization.

the clavicles, tarsal bones, ribs, vertebrae, mandible, skull, shoulder girdle and pelvis are involved. When a long bone is the seat of the disease, most or all of the shaft becomes involved. The history of trauma is not infrequent. Clinically the common first symptom is pain which is usually intermittent at first in contrast to osteogenic sarcoma. Frequently a long interval of freedom from pain may occur, lasting for several months. With each successive attack the pain becomes more severe and more prolonged and the interval shorter, until finally a permanent rheumatoid character of pain is established, usually with the appearance of a distinctly palpable tumor. Fever occurs with attacks of pain and occasionally is rather prominent, simulating the clinical picture of osteo-

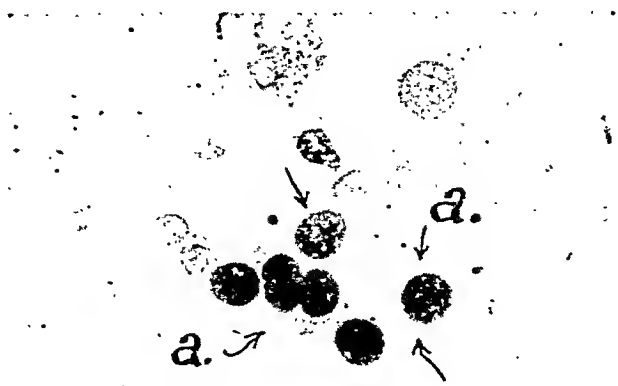


FIG. 4. Dural metastasis may be diagnosed by presence of Ewing's cells in the spinal fluid (post-mortem lumbar puncture). Tumor cells at a.

myelitis or rheumatic fever. The tumor mass, when apparent, may be associated with considerable local hyperemia as well as enlarged regional lymph nodes. The tumor mass increases with each attack of pain until a permanent enlargement results. Joint involvement is rarely if ever seen. Pathological fracture is also rare until the terminal stages. The clinical course may be prolonged for years before the development of metastases; frequently, however, it may be only a few months' duration. With the development of metastases, especially within the lung, high fever may occur. Metastases are often first demonstrable in the skull. With or without radiation therapy remissions of many months may occur. Other viscera, such as the liver, kidney and spleen are involved, but rather infrequently. Among the clinical findings the following are encountered with surprising frequency: (1) history of trauma, (2) intermittence of symptoms including fever, (3) a mistaken diagnosis of chronic osteomyelitis in the case of long bones, or (4) of tuberculosis in the presence of the vertebral involvement.

According to Ewing⁶ this tumor, which he classifies as "solitary diffuse endothelioma," causes widening and slow absorption of the shaft without a trace of bone production. The soft tissues are gradually invaded. The most striking feature, best demonstrated by the roentgen ray, is the involvement of a large segment or the whole of the shaft, which distinguishes the process from osteogenic sarcoma and the giant cell tumor. This location together with homogeneous demineralization of a slightly widened shaft, generally permits a diagnosis from the roentgenogram alone, especially if the tumor recedes rapidly under roentgen or radium treatment.

The histogenesis of Ewing's tumor is still subject to discussion among most authorities. Basically the tumor consists of solid cords of cells separated by fibrous bands, thick or thin. Delicate reticulin fibers may exist between individual tumor cells or may be absent. The cells generally are rounded

unless closely packed, then are polygonal. The size is two to four times or more that of a small lymphocyte. The nuclei are rounded and the cell outline is indistinct. Often capillary blood vessels occur, either in septa or lying among the tumor cells. According to Oberling and others, reticulum cells are present; other authors deny this (Ewing and Foot). According to Stout¹⁴ it is impossible to separate reticulum cell sarcoma and Ewing's tumor, and he agrees with Oberling that they are variants of the same tumor. Pseudorosettes may occur, which according to some may prove that these are neuroblastomas with bony metastases. This is denied by others. According to Oberling embryonal types of erythropoiesis and myelopoiesis may occur in some tumors and in his opinion the tumor is a reticulum cell sarcoma, most often seen as a cellular blastema without any differentiation or with differentiation into reticulin-forming tumor, endothelium-forming tumor, or a myelopoietic form, and so forth. This view is denied by Ewing. Stout, however, is inclined to Oberling's concept, particularly in view of the fact that Ewing himself admits that the process appears to begin in the perivascular endothelium. Neely and Rogers¹¹ agree with Melnick that the cell of origin is the undifferentiated mesenchymal cell which in postnatal life is found about small blood vessels and capillaries, typically being an undifferentiated round cell sarcoma, composed of cells not yet sufficiently mature to form reticulum. In atypical neoplasms in which the tumor cells are somewhat more differentiated, they may assume morphologic and physiologic properties of the fibroblast or fibrocyte, become spindle shaped, produce reticulum, and, with still more cellular differentiation, possibly form bone. Differentiation may also proceed along another line, producing reticulo-endothelium and myelocytic elements and may resemble the microscopic picture found in lymphoblastoma. The cell of origin in their opinion, therefore, is the same as in fibrosarcoma, osteogenic sarcoma and

lymphoblastoma, and histopathologic classification depends on the line and extent of differentiation of the tumor cells.

Our own studies of cases at this hospital have provided little basis for formulation of an independent opinion. In some of the cases the relation of tumor cells to blood vessels is so characteristic that it is difficult to escape the conviction that the tumor is itself an endothelioma, as originally suggested by Ewing. Certain features of the histopathology of the disease deserve emphasis and may provide a basis for classification. These are (1) the lack of intercellular matrix, (2) the rudimentary cell type with slight if any differentiation toward a spindle cell, (3) the remarkable uniformity of the tumor cells both in the primary lesion and in the metastases, (4) the lack of marked anaplasia histopathologically despite the obvious malignancy of the disease, (5) the striking morphologic similarity between tumor cells and the cells of normal embryonal tissues in an exceedingly primitive stage of development, i.e., before the determination of cartilage, muscle, and other specific tissues from the undifferentiated mesoderm (Fig. 5). Because of the constant association of this tumor with a bone locale it seems necessary to relate this tumor in some manner to osteogenic mesenchyme. Many of the features listed above are characteristic of embryonal neoplasms in general. This is an important distinction for all tumors and should be kept in mind in any attempt at classification. As stated by Ewing,⁷ "The embryonal nature of a tumor should not be confused with an anaplastic character. While many embryonal carcinomas are also highly anaplastic, others are relatively slow in growth and vary little from the cells of origin. The failure to distinguish between embryonal and anaplastic characters gives rise to much misapprehension regarding the prognosis of cellular carcinomas, since embryonal carcinomas are very prone to sudden variations in growth, they often respond to x-ray treatment, and their

course is distinctly less malignant than that of anaplastic carcinoma of corresponding structure.

"Embryonal carcinomas must be conceived as arising from embryonal structures, often misplaced, and, since the cells of origin are imperfectly developed, the tumor reflects this character throughout. The embryonal character does not signify that there has been any reversion of the

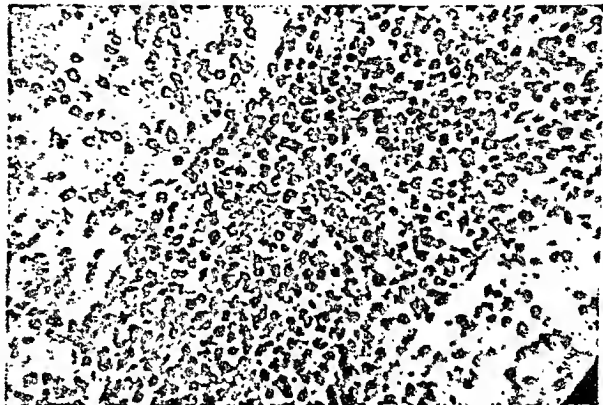


FIG. 5. This slide shows the morphology of cell structure in a 2 cm. fetus. Note the delicacy of structure and small size of the cells which are almost completely filled by their nuclei.

originating cells of the tumor from an adult to an embryonal type. It is possible to grade the carcinomas of many organs according to this principle, as adult or embryonal"

Inasmuch as an intercellular matrix is not apparent in this stage of development of the tumor cells one must anticipate the complete failure of the tumor cell, lacking a suitable substrate, to manifest any osteoformative properties. In any event it seems logical to interpret the disease, on circumstantial grounds at least, as a form of *embryonal osteoblastoma, nonosteogenic*, possibly bound up with certain dysontogenetic factors.

The value of such classification at this time is largely academic. Nevertheless, it may possibly open an avenue of approach to the eventual understanding of the disease in terms of constitutional diathesis and dysplasia (hamartia). Many parallels may be drawn between this tumor as an



FIG. 6. Synovial sarcoma simulating Ewing's tumor. This was believed to be an embryonal synovio-blastoma. Note clefts simulating rudimentary synovial spaces in a few areas, at *a*.

embryonal osteoblastoma and other embryonal tumors, for example embryonal carcinoma of the testis (seminoma) and neuroblastoma of the adrenal or kidney.¹ Examples may be multiplied to include many types of tumor, even certain tumors of synovia as in a case recently observed here in which the first impression was Ewing's tumor (Fig. 6 and 7). In all these tumors the characteristic feature is the monotonous regularity and uniformity of cell type, the rounded delicate nucleus, scanty cytoplasm, the syncytium-like formation of solid sheets of tumor in which the scanty cytoplasm is faintly stained or indistinct, and the lack of differentiation into any well defined structural units except perhaps occasional formation of rosettes and pseudorosettes, especially around blood vessels. In many of these cases, too, a dysontogenetic basis is often underlying.

ROENTGENOLOGIC AND THERAPEUTIC CONSIDERATIONS

In a recent survey of the literature concerning bone tumors it becomes apparent that there is considerable difference of opinion regarding the value of roentgen examination in diagnosis and as a guide in the choice of the method of treatment. We have reviewed the bone tumors which we have encountered since the opening of the Percy

Jones General Hospital, January 15, 1943. To date there have been 30,442 admissions of which 55 were for such tumors, 24 of which were malignant, constituting a ratio of 1 malignant bone tumor to each 1,263 admissions. Comparison with the figures from a large civilian institution is of interest. Meyerding and Valls¹⁰ state, "Bone tumors are rare in civilian practice, but comprise one out of every four thousand patients entering the Mayo clinic"; in other words, an admission rate of 0.025 per cent. In Meyerding's study of cases admitted between 1909 and 1934, 114 patients with Ewing's tumor were treated, i.e., approximately 27 per cent of 424 primary malignant tumors of bone encountered. According to statistics compiled by Swenson, 26 cases of Ewing's tumor were studied at Presbyterian Hospital between 1906 and 1942, a period of thirty-six years. This



FIG. 7. Cystic lesions and bone condensation changes in proximal third of the tibia. This was diagnosed from tissue sections as a synovioma simulating Ewing's tumor. The morphology was so embryonal that it was differentiated with difficulty from the classical picture of Ewing's tumor. Patient was a twenty year old T/5 who had pain in the right knee starting in September, 1943, and continuing in March and April, 1944, with recurring episodes of hydrarthrosis, following which a lump was noticed over the medial tibial condyle. Biopsy by Colonel Francis McKeever revealed bilobed cavity and an extraosseous mass which looked like neoplastic tissue. Bilobed cavity is shown at *a*. Histopathological findings are shown in Figure 6.

indicates that less than one case a year is seen in this large civilian institution. A survey of the cases in Percy Jones General Hospital shows that there is a very high proportion of Ewing's tumors, being approximately 42 per cent of malignant bone neoplasm encountered in this small series.

According to Rigler¹³ there is great value in the roentgen examination of any suspected bone tumor. The roentgenogram ordinarily will indicate whether the tumor is intrinsic or extrinsic in relation to the shaft, whether it is benign or malignant and often will give an accurate index of the extent of involvement. In some cases the type of tumor present may accurately be determined. On the other hand, it has also been said "There is no such thing as a positive diagnosis of a malignant bone tumor with x-ray."

The above controversy is one in which we prefer not to become involved, for it is obvious that given a proper diagnostic examination and experienced interpreter, the roentgen findings are of inestimable value, and in some instances may actually be more diagnostic than the pathological report based on insufficient biopsy material (Fig. 20). In the triad of diagnostic features, the histopathologic, the bedside examination and the roentgenographic study, each plays a necessary part and no one of these should be neglected. Early, accurate diagnosis depends upon the proper interpretation of all three factors which we believe are complementary and not antagonistic. As is stated by Brailsford,² it seems reasonable to assume that "... a positive finding in any one should be regarded as a dominant factor."

One source of difficulty in reaching an early diagnosis in Ewing's tumor is the fact that very often these patients have rheumatic pains and various ill defined complaints and are classified as "goldbricks" by the uninitiated and given liniment, hot packs, and sometimes the well known "brush-off." It would seem axiomatic, therefore, to state that a meticulous history and physical examination are imperative in

individuals with vague complaints, and emphasis should be placed on repeated roentgenographic examinations whenever there is doubt regarding diagnosis.

The following case histories stress the importance of an early roentgenographic examination:

CASE I. A white male private, aged twenty-one, was admitted to Percy Jones General Hospital, December 23, 1943. He had been inducted into the army December 5, 1942, but prior to this time for five or six years had complained of intermittent shooting pains in the right thigh. Pain was most severe in the region of the knee and the patient complained of a dull gnawing ache in the mid-thigh. Three days following induction he reported to sick call and after numerous visits was finally hospitalized May 8, 1943. He was examined at a Station Hospital for foci of infection, but no roentgenograms were made. In September, 1943, nine months after induction while on maneuvers he turned to get a shovel from a truck and suffered a complete pathological fracture of the mid-portion of the right femur. Roentgenograms made at Brooke General Hospital in Texas revealed a tumor and biopsy showed Ewing's sarcoma. He was transferred to this hospital for deep roentgen therapy. The patient received treatment to multiple fields, but after a retrogressive course ending in debilitation the patient died September 26, 1944, nine months after admission (Fig. 8, 9 and 10).

CASE II. A white private first class, aged twenty, was admitted to Percy Jones General Hospital August 27, 1943, with a complaint of pain in the right heel, first noted in March, 1943. At this time he reported to his dispensary, was told that he had a sprain and to "forget it." A week later, the pain persisting, the ankle was strapped, but no improvement was noted. In April, 1943, he entered a Station Hospital for repair of a hernia. His foot continued to pain. In May he was transferred to another Post where, following strenuous exercise, he again found it necessary to report to the dispensary. He was thereupon hospitalized and treated with "hot packs" for eighteen days, following which biopsy was done. This revealed a Ewing's tumor. The patient was then transferred to this hospital where heavy preoperative roentgen therapy to the os calcis and 100 r (air) to the

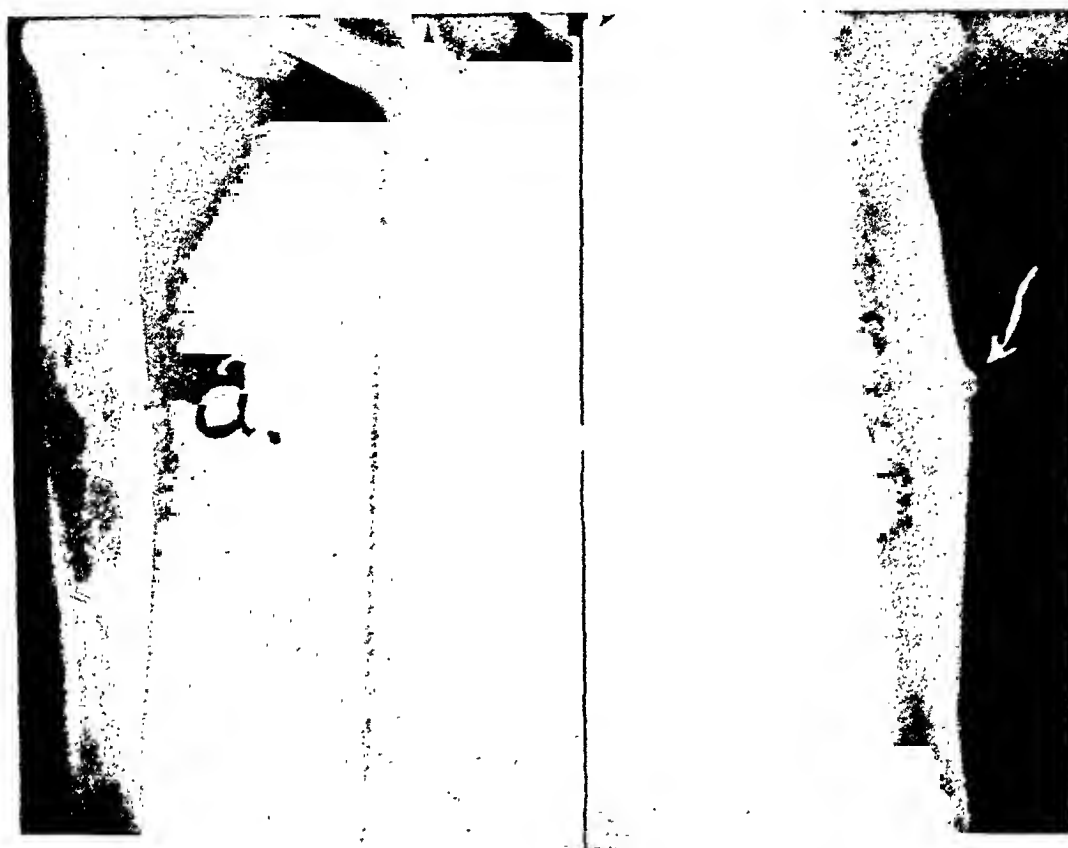


FIG. 8. Case 1. Ewing's tumor of femur involving 32 cm. of the shaft. Note expansile character of the lesion and multiple lucid areas involving the distal two-thirds of the shaft. A pathological fracture is seen at *a*. On the right the appearance following 2,000 r to each of four fields covering the entire shaft of the femur. Note the marked improvement in appearance following deep roentgen therapy.

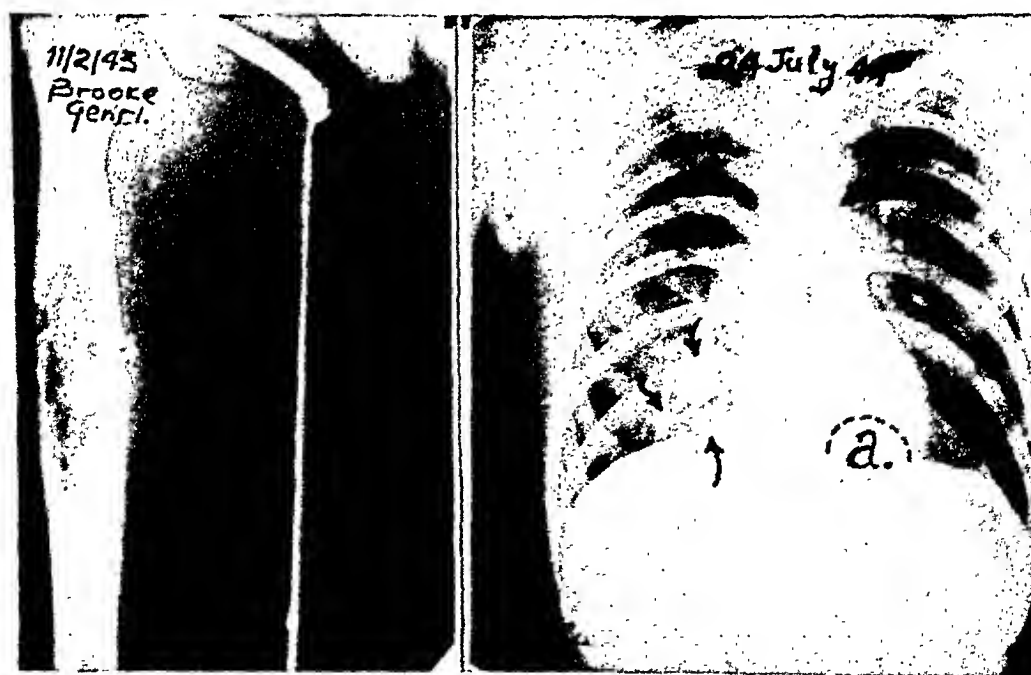


FIG. 9. Case 1. Shows the femoral shaft in original films made at Brooke General Hospital on 11/2/43. On the right the appearance of the chest seven months later. Numerous metastatic nodules are evident in the right lung field. There is a large metastatic lesion behind the cardiac silhouette at *a*. Close inspection of the cardiac silhouette and the domes of the diaphragm is imperative. Not infrequently the earliest metastatic deposits will be found in the costophrenic sulci.



FIG. 10. Case 1. Ewing's tumor, same case as Figures 8 and 9. This shows metastatic lesion in left acromion. Film made in February, 1944; lytic lesion is indicated at *b*. In May, 1944, a large defect was found in the sacrum at *a* and the left transverse process of the fourth lumbar vertebral body was subsequently found to be completely destroyed, at arrows. At the same time metastatic disease became evident in the calvarium as shown in the left lower illustration. Lesion at *c* looked very much like a venous lake, but a nodule could be palpated in this region on clinical examination.

entire thorax was given, following which on October 28, 1943, a Gritti-Stokes amputation was done. No viable tumor cells were found in the resected specimen (Fig. 11). The patient was discharged to a Veteran's Facility, but in July, 1944, nineteen months after the beginning of his illness, metastatic nodules were found in the left lung field. He died at home of "cardiac failure" November 7, 1944 (Fig. 12, 13, and 14).

Pitfalls in Roentgen Diagnosis. Much to the credit of forward echelons, very early diagnoses of bone sarcomas have frequently been made and substantiated by subsequent biopsy. On the other hand, obvious errors are also apparent. In one instance a lytic lesion of the femoral condyle was interpreted as an "eosinophilic granuloma" and in another the "sun-ray" periosteal reaction of an invasive, rapidly growing osteogenic tumor was construed to indicate the presence of callus about a fracture which was nonexistent (Fig. 15). As pointed out by Sutherland¹⁵ failures in arriving at a proper diagnosis "... must be attributed to a lack of knowledge and ex-

perience on the part of some diagnosticians and carelessness in the use of knowledge and experience on the part of others." Such failures should not be blamed on the roentgen method.

It is quite certain that early in the growth of Ewing's tumor the roentgen findings are not characteristic enough to warrant a positive diagnosis, but obscure lytic changes in bone should be followed by serial roentgenography and early biopsy. Minimal periosteal proliferations should be looked upon with concern and not considered to represent "osteomyelitis" until proved otherwise, for it is well known that roentgenographically and clinically, Ewing's endothelioma closely simulates nonspecific bone infection from which it is differentiated with difficulty.

One type of Ewing's tumor likely to give trouble in roentgen diagnosis is that located in the sacrum. In the differential diagnosis of sacral tumors, among other lesions one must consider chordomas, located centrally, neurofibromas extending along the course



FIG. 11. Status after irradiation, showing disappearance of tumor cells. The remaining cells resemble embryonal mesoderm as seen in Wharton's jelly. Residual myxomatous tissue at *a*. Bone spicule at *b*.

of the sacral nerves and ependymal cell gliomas. According to Camp and Good, Ewing's tumor is far from characteristic in the sacrum being much more typical when involving long bones. With Ewing's endo-

thelioma of this portion of the pelvic girdle, the roentgenologist can only make the diagnosis of malignant disease. The following case report emphasizes the difficulties in diagnosing a Ewing's tumor of the sacrum.

CASE III. A thirty-nine year old T/5 was referred to the Roentgen Therapy Section of

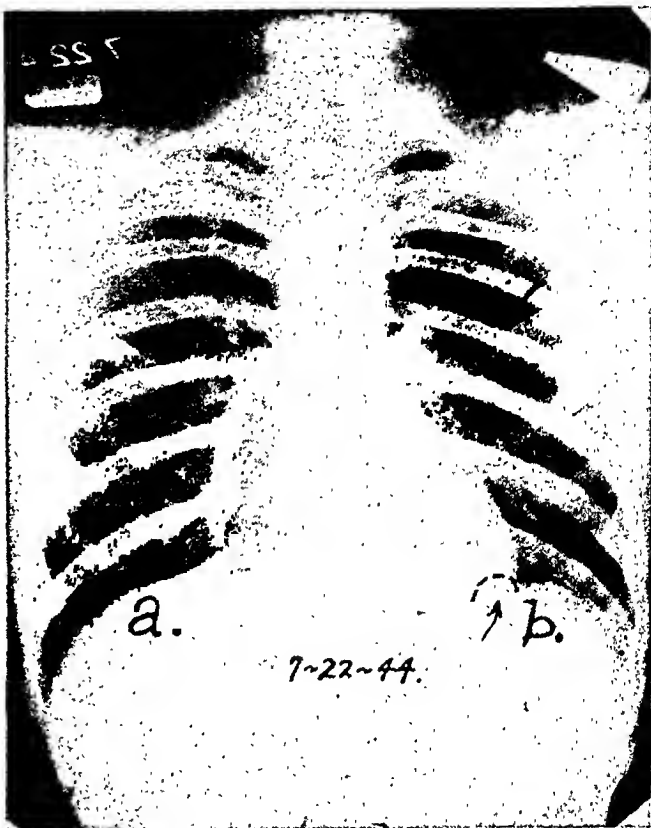


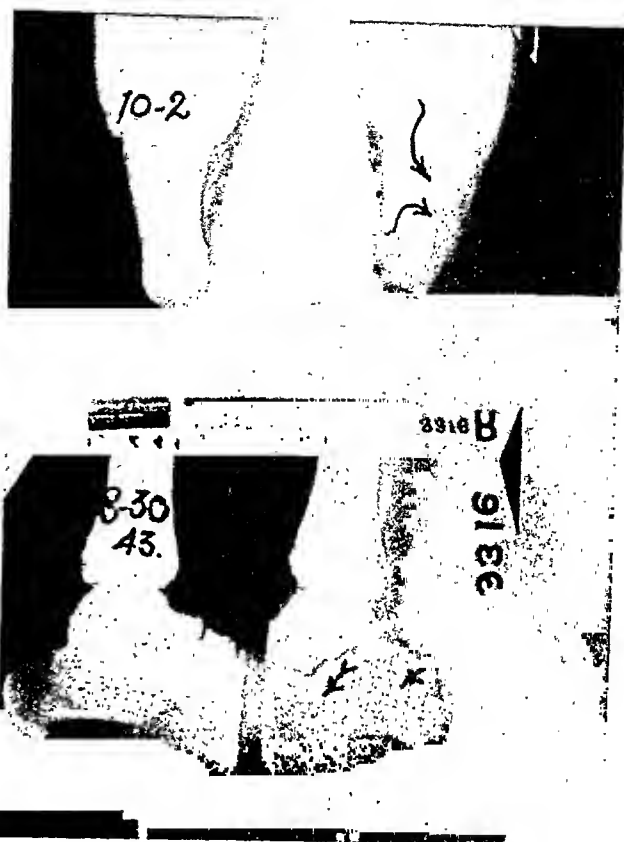
FIG. 13. Case II. Showing early metastatic lesions in left lung field. Careful inspection of the regions indicated at *a* and *b* is most important in order to exclude early metastatic sarcoma behind the domes of the diaphragm. In this particular case a faint metastatic deposit was noted behind the apex of the heart. The nodule is indicated by the lower arrow.

Percy Jones General Hospital for treatment on November 13, 1944. He gave a history of severe lancinating pains in the right buttock of seventeen months' duration. Four months before there had been a sudden increase in the pain after the patient was thrown from his feet. Roentgen study revealed a large tumor arising from the right hemisacrum in the region of the anterior sacral foramina, some of which appeared dilated. On the basis of previous experience with neurocutaneous syndromes and von Recklinghausen's disease the diagnosis of



FIG. 12. Case II. Ewing's tumor in twenty year old Pfc. with history of painful heel of five months' duration, showing Ewing's tumor involving the posterior portion of the os calcis. There is no sharp line of delineation between the tumor mass and the surrounding normal bone. Tumor at *a*.

FIG. 14. Case II. Showing appearance of the right os calcis in the axial view with left side for comparison, above. Lateral projections, below. When this patient reached us there was a large soft parts mass which had burst through the shell of the os calcis. Lytic areas in the right os calcis are indicated by arrows. Histopathological findings are shown in Figure 1.



neurogenic sarcoma was suggested. We felt that a neurofibroma or an ependymal cell glioma were possibilities and that a chordoma was not very likely. A punch biopsy was attempted, but was unsuccessful (Fig. 16).

The patient was given a small amount of palliative roentgen therapy (800 r to a large sacral field) and referred to the Orthopedic Section for biopsy, and possible surgical removal. At operation, November 22, 1944, the neoplasm was found to be inoperable, but several specimens were obtained and the following report rendered by one of us (S.E.M.): "It appears we are dealing with a sarcoma possessing embryonal characters, i.e. round nuclei, scanty delicate cytoplasm and syncytial arrangement in compact masses. Anaplasia is relatively slight and mitoses are few. There is abundant necrosis and hyalin scarring. It is difficult to assign a derivation to the tumor,

but from the morphology of the cells, including their embryonal aspects, their lack of anaplasia and the marked abundance of thick-walled, poorly formed blood vessels, the most plausible



FIG. 15. Characteristic roentgen picture of osteoblastic-osteogenic sarcoma of the proximal third of the right humerus. Note Codman's triangle at *a* and bone production in the axillary lymph nodes at *b*. This profuse type of "sun-ray" proliferation should not be mistaken for abundant callus. The fact that the lymph nodes show evidence of bone production in this region proves that the primary tumor cannot be Ewing's sarcoma since Ewing's tumor is nonosteogenic.

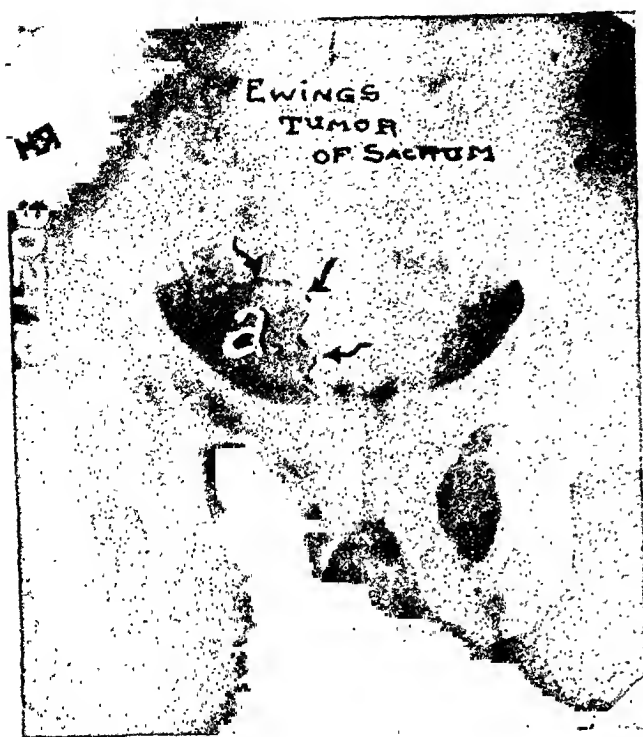


FIG. 16. Case III. Ewing's tumor of sacrum. Soft tissue tumor at *a*. This large mass displaced the rectum anteriorly, and appeared to rise from the region of the anterior sacral foramina. The roentgen picture is not characteristic. The following diagnoses were considered: neurogenic sarcoma, neurofibroma, ependymal cell glioma, chordoma. The lateral position of the tumor would tend to rule out the last diagnosis.

diagnosis is Ewing's tumor." Additional deep roentgen therapy was given between December 4, 1944, and March 13, 1945, to each of four large fields receiving 3,000 r and a lateral sacral field received 800 r (air). Patient is asymptomatic at present time (two years and one month since onset of symptoms).

The above case requires some comment. This lytic lesion of the right sacrum was considered on the basis of the roentgenogram to be some type of malignant tumor. The appearance was distinctly unusual for Ewing's tumor, the lesion apparently being sharply circumscribed. In this case we were unable to determine roentgenographically the type of tumor present, although review of some of our material indicates roentgen diagnosis can be highly accurate. It is enough, in our opinion, to call attention to the fact that a tumor is probably malignant without identifying the type of cell present; on the other hand, the clinicoroentgenologi-

cal findings are often such that the type of osteogenic sarcoma can be surmised. This, of course, does not mean that we are making a "positive diagnosis" of the cell type, but are merely calling attention to the possibilities and probabilities on the basis of appearance and previous experience. If there is any probability of a lesion being Ewing's tumor, the importance of the therapeutic test should not be overlooked. Small doses of 100 to 150 r will often cause rapid regression of the tumor so that after as few as two to three treatments the patient's night pain is completely relieved. According to Cutler, Buschke and Cantril⁵ the therapeutic test "... is often superior to histological examination in its diagnostic significance." The radiosensitivity of Ewing's tumor places it apart from all other bone tumors.

In regard to the other osteogenic tumors, it has been our experience that relief of pain either does not take place with a reasonable amount of roentgen therapy (1,500 to 2,000 r to multiple fields) or else the analgesic effect is delayed for a matter of two to four weeks. If the lesion involves a considerable extent of the shaft of a long bone with slight evidence of periosteal reaction to begin with, but following therapy shows evidence of considerable deposition of calcium in the periosteal and subperiosteal region and if at the same time the patient has had marked relief of pain within two to four days after the onset of deep roentgen therapy, the diagnosis of Ewing's tumor can usually be made without hesitation. The following case report is an example of the response of a Ewing's sarcoma to roentgen therapy:

CASE IV. A white officer, aged twenty-eight, was admitted to the Percy Jones General Hospital on October 25, 1944, with a complaint of swelling of the left leg and muscle fatigue of approximately one year's duration. The pain was not severe and was attributed to strenuous marching. One month prior to admission he noticed tumefaction of the leg, but the pain remained at a minimum. He reported to the dispensary and was told to apply "hot packs."

When first seen in the Roentgen Department he was complaining of severe pain in the left leg. Roentgen examination made just prior to this time showed a diffuse increase in the diameter of the fibula extending from a point about 2 inches distal to the proximal fibular head downward to the junction of the middle and distal thirds. The following comment was a part of the reports of the roentgen examination: "The bone in this area is definitely irregular in density. There is a calcification

soft parts. The patient had been completely free from pain since his second treatment. On December 5, 1944, an amputation of the left leg was carried out by the Orthopedic Department. At this operation a tourniquet was placed around the leg at the level of the popliteal space and another tourniquet around the leg at the highest possible level of the thigh. An incision made over the fibula revealed a tumor mass which grossly showed evidence of invasion of the muscles and was obviously malignant.

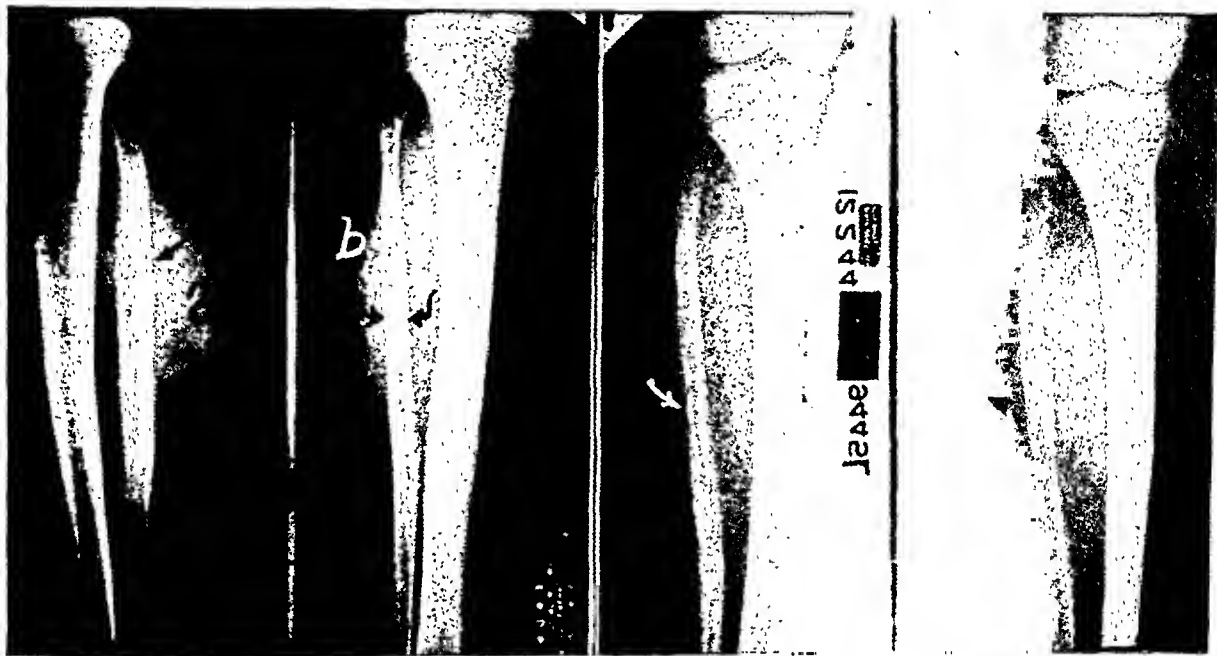


FIG. 17. Case IV. Ewing's tumor of fibula. Soft tissue tumor at *a*. The compact bone of the middle third of the fibula is infiltrated and honeycombed by tumor cells. There is a slight constriction of the fibula at *b*. Very slight periosteal reaction is noted in the extreme right film just adjacent to the arrow. This patient, a twenty-five year old Captain in Ordnance, gave a history of "muscle fatigue" of one year. Severe pain did not play an important rôle in this patient's history. Marked improvement followed roentgen therapy which was followed by mid-thigh amputation.

beneath the periosteum and there is a definite suggestion of destruction of the cortex in the anterior one-third of the fibula. These changes strongly suggest the presence of a malignant tumor. We believe that a so-called Ewing's tumor is more likely than an osteosarcoma. The other bony structures seem to be normal" (Fig. 2 and 17).

Roentgen therapy was completed on November 28, at which time the patient had received 2,000 r (air) to each of two fields crossfiring the proximal two-thirds of the left leg. On December 4 re-examination of the left lower leg showed quite extensive calcification along the margins of the involved portion of the fibula and a marked decrease in the size of the mass in the

Without removing either tourniquet an amputation was carried out through the middle third of the femur, cutting equal anterior and posterior flaps. The patient's postoperative course was uneventful and no metastases have been found to date.

Pathological diagnosis: Ewing's tumor, left fibula, invading muscle.

Comment. An exact diagnosis was made on the basis of (1) the response to roentgen therapy, (2) a rather characteristic roentgen picture with evidence of deposition of calcium in the tumor after adequate therapy. Amputation was done without biopsy, but only after ascertaining that there was evidence of malignant disease invading muscle.

We feel that in a *doubtful case* biopsy should always be employed; however, it is worth while to recall that Ewing⁷ has stated in regard to osteogenic sarcomas in general that treatment "... is a difficult and complex subject," and also, that if the simple plan of biopsy and amputation is carried out indiscriminately "... it will soon appear that many unnecessary and unsuccessful operations are performed, several important aids in diagnosis, prognosis and treatment now available will be ignored and the best interests of the patient are not conserved."

Another example of the efficacy of roentgen therapy in establishing a diagnosis of Ewing's tumor is as follows:

CASE V. On March 22, 1944, a First Lieutenant aged twenty-three, was referred to the Roentgen Therapy Department of our hospital for consultation. He gave a history of pain starting in the low back and joints of the right leg while moving cases of beer for his father in 1940. This pain was "toothache like" in character. It was more pronounced in the joints. In June, 1942, after finishing primary training, he noticed pain in the back and legs which caused him to limp. He was given some pills and light therapy at this time and the pain disappeared. In August, 1943, his teeth were checked and no foci of infection were found. In January, 1944, he noticed a slight swelling of the right thigh while in the shower, and was immediately transferred to Letterman General Hospital where roentgen therapy was given to multiple fields (six) crossfiring the right thigh, 1800 r (air) being given to each of six fields measuring 10×15 cm. in diameter. The pain in the back and joints of the leg left forty-eight hours after the beginning of treatment and this swelling subsequently disappeared.

Roentgenograms showed a widening of the shaft in the proximal half of the right femur with "onion-peel" and "sun-burst" periosteal reaction indicating some form of irritation of the subperiosteal space. It was our opinion that if bone infection had been present and 1,800 r had been given to each of six fields a severe reaction would have resulted. Instead his symptoms promptly subsided. In view of the fact that there was a definite skin reaction outlining the various fields used, it was decided

that no additional treatment was indicated and that biopsy should be considered.

Diagnosis of the Roentgen Therapy Department: "Ewing's tumor." Colonel Francis McKeever concurred in this opinion and it was decided by the Tumor Board to do a biopsy which was carried out on March 29, 1944. A large block of bone was removed from the lateral aspect of the femur at the site of the lesion. This measured 1×3 cm. and included periosteum, subperiosteal tissue, cortex and medulla. The specimen was seen by the pathologist who deemed it adequate and a report dated April 25 was as follows: "Dense scar tissue and fragments of bone undergoing absorption and necrosis. No evidence of tumor seen" (Fig. 18).

The patient was discharged from the hospital with the following diagnosis: "Osteomyelitis, chronic nonsuppurative, femur—right, upper third. Moderate. Cause—undetermined."

It was felt that he should be restricted to the continental limits for duty. The patient was traced by letter and on March 14, 1945, the following communication was received from the Chief of the Orthopedic Section at Letterman General Hospital:

"As you remember, Lt. — was returned to duty by the Disposition Board and sent to Santa Ana Air Base. Seven days after his return, while playing baseball he sustained an oblique fracture of the right femur through the pathological area in the region of the biopsy. He was hospitalized. From that time until the 1st of November, 1944, when he was readmitted to Letterman, his fracture was treated by skeletal traction and healing of the fracture was quite slow. In September, 1944, he developed symptoms and signs compatible with a cerebellopontine angle tumor. An exploration at the Station Hospital revealed an invasive neoplasm which was diagnosed by the Army Medical Museum as 'probable myeloma, radiosensitive.' Chest x-rays now revealed pulmonary metastases and a course of palliative x-ray therapy was instituted. At postmortem no tumor cells were found in the femur and the x-ray department considered the primary cured, but death from pre-existing metastasis occurred."

This case report stresses again the importance of the therapeutic test in Ewing's tumor and shows that even in spite of a negative biopsy that the original lesion was an endothelial myeloma which later metastasized to the chest and brain.

There are a number of other pitfalls in diagnosis which should be mentioned,

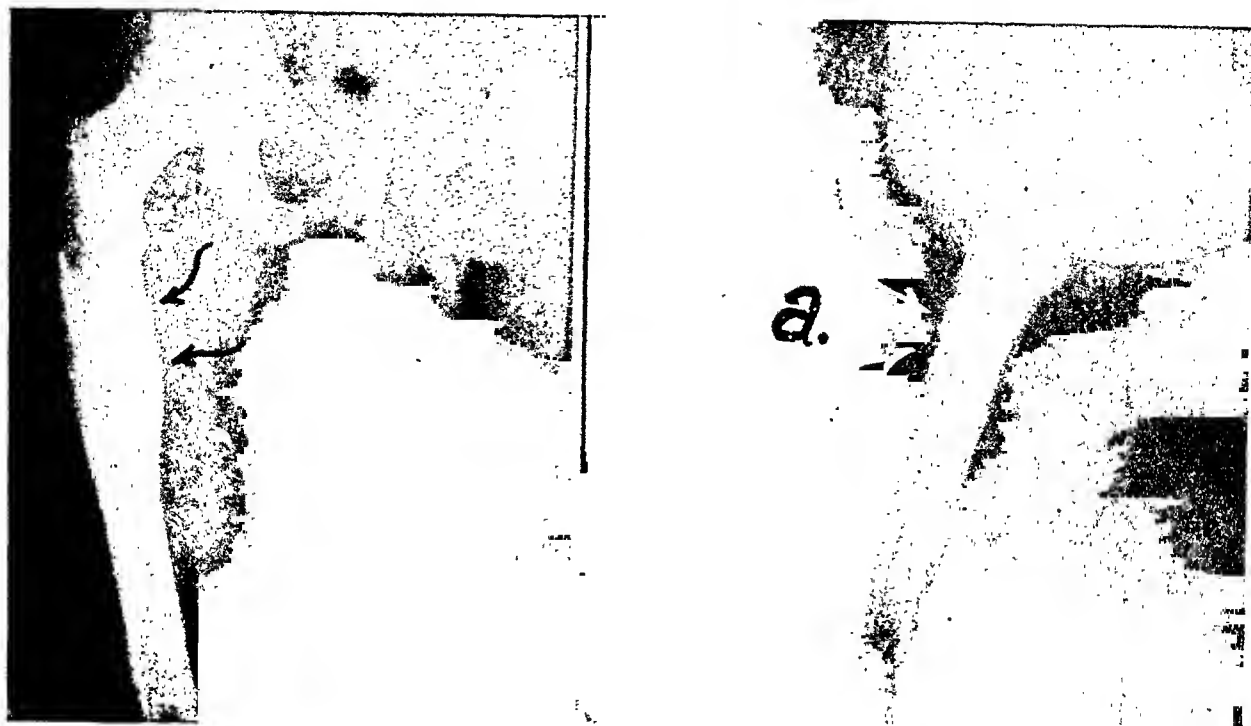


FIG. 18. Case v. Ewing's tumor in twenty-three year old Air Force Lieutenant with history of toothache-like pain in the right leg since 1940. Treated at Letterman General Hospital with deep roentgen therapy with prompt relief of pain and swelling of right thigh. Because of the dramatic response to treatment a diagnosis of Ewing's tumor was made. Subsequently a very adequate biopsy was obtained. Pathological diagnosis: chronic nonsuppurative osteomyelitis of the right femur. The patient returned to duty, but later developed signs of increased intracranial pressure due to a possible cerebellopontine angle tumor. Death occurred November 6, 1944. Postmortem revealed evidence of metastases to brain, skull, lungs, pleura and dorso-lumbar spine. No tumor cells were found in the primary lesion of the femur, which had been completely controlled by 1,800 r to each of six fields cross-firing the lesion. Minimal periosteal reaction was observed at *a* on original roentgenograms.

among which are intercurrent disease such as syphilis. In one of our cases a history of chancre together with roentgen evidence of spontaneous regression in the size of the tumor made diagnosis difficult. It is well to remember that in Ewing's tumor there may be spontaneous increase and decrease in the size of the lesion. This may explain the well known clinical observation of alternating episodes of pain interspersed with comfortable periods. The following case history is illustrative:

CASE VI. A private, aged twenty-four, was admitted February, 1944, stating that three years before admission he struck his left foot in an army truck accident. He strapped his foot and continued on duty. Six months later considerable pain and swelling were noted in this area and this became progressively more prominent. In October, 1943, a biopsy was obtained and a pathological report of hemangio-

endothelial sarcoma was made and confirmed by the Army Medical Museum.

Shortly after admission to this hospital it was noted that the tumor had regressed and that the bone lesion had apparently healed. It was then discovered that the patient had a history of chancre in July, 1942, and in view of the fact that a luetic lesion may mimic any type of bone lesion, it was felt advisable to repeat the biopsy before treatment was instituted. This was done and the original diagnosis was confirmed. The patient was given roentgen therapy between March 17 and May 2, 1,800 r (air) being administered to two large fields, cross-firing the great metatarsal and surrounding soft tissue region. Following this treatment the patient complained of moderately severe pain in the foot extending up the left leg. On May 5 an amputation was performed, through the middle third of the left lower leg and a prosthesis was fitted July 8, 1944. No viable tumor cells were found in the resected specimen.

The patient was discharged. He is living and is well at this time with no evidence of pulmonary metastasis, but complains of occipital headache. So far no metastases have been demonstrated in the cranium (Fig. 19).

It should not be inferred from the above cases that all Ewing's tumors are radio-sensitive. Neoplasms vary in sensitivity

bed and the patient's general resistance. Indeed, the only true measure of radio-sensitivity is a test by thorough irradiation.

CASE VII. A patient, aged twenty-three, was admitted to Percy Jones General Hospital June 14, 1943, with a history of pain in the left leg of two years' duration. Tumor of the femur was discovered six months ago at Letterman

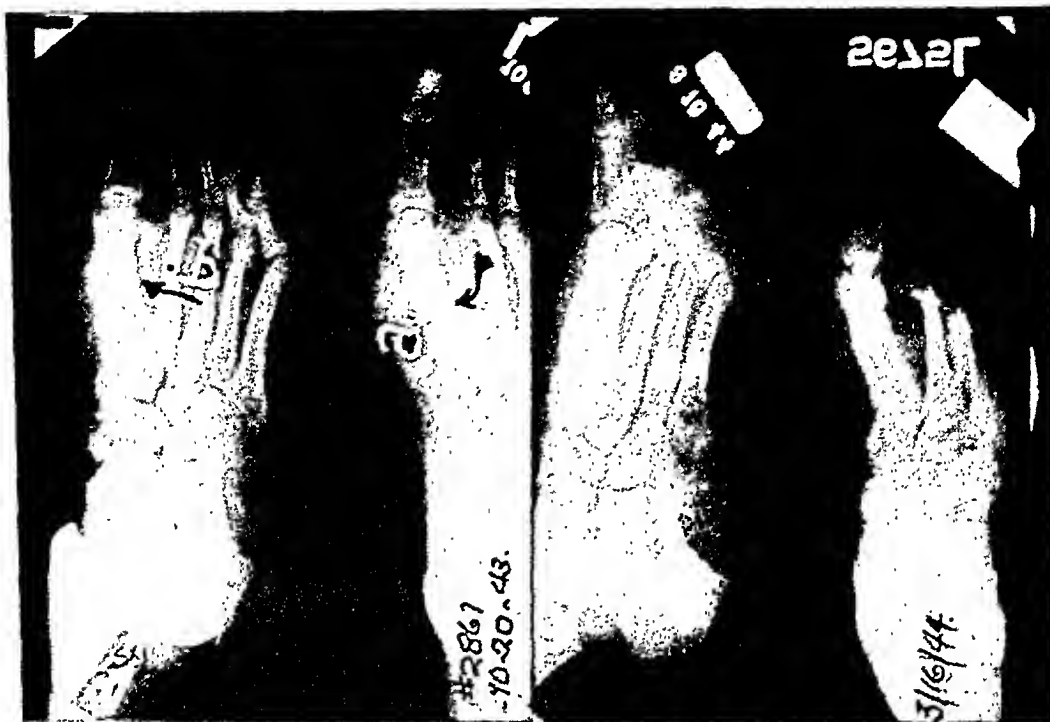


FIG. 19. Case vi. Ewing's tumor involving left great metatarsal. A pathological fracture is seen at *b*. The shaft is increased in width and there is a soft tissue tumor at *a*. On the right the appearance of the foot following surgical biopsy done elsewhere. The soft tissue tumor has regressed and the great metatarsal fracture has healed. Spontaneous regression of Ewing's tumor will sometimes occur, leading one to the erroneous impression of a benign lesion.

according to inherent characteristics which often are little understood. Although most of the embryonal round cell sarcomas which have been treated in our clinic have been at least temporarily radioresponsive, experience in roentgen therapy teaches that there are exceptions and that even very embryonal tumors are sometimes radioresistant. The reverse is also possible; i.e., a very well differentiated tumor may respond dramatically to deep roentgen therapy as it did in the following case.* The reason for this is not clear, but probably depends upon certain factors having to do with the vasculoconnective tissues of the tumor

General Hospital. The patient had lost 40 pounds in weight and the muscles of the left thigh were considerably atrophied. Roentgen examination showed an irregular punched-out lesion of the middle third of the femur surrounded by a fusiform expansion of cortical bone. Original roentgenograms suggested primary bone tumor or sclerosing osteomyelitis. Biopsy at Letterman General Hospital reported "... atypical telangiectatic osteogenic sarcoma or malignant angio-endothelioma of the femur." However, on the basis of tissue submitted to the Army Medical Museum for review it was felt that amputation was not indicated. A benign lesion was suggested, possibly an "ossifying angioma of bone." The original sections were reviewed in our Pathology Department and it was felt that in view of the night pain and sclerotic changes plus the

* Previously reported by Bell, J. C., and Heublein, G. W., in *Radiology*, 1944, 43, 425-428.

appearance of atypical osteoid with patchy calcification that this might represent an "osteoid-osteoma." However, after reviewing all films the Roentgen Department on June 16, 1943, rendered the following report: "Considering all the films in this case it would seem that we are dealing with a primary malignant bone tumor, probably an osteogenic sarcoma of some type." The tissue sections were reviewed by two eminent pathologists, one of whom considered the sections quite typical of osteoid-osteoma while the other suggested the definite possibility of a metastatic lesion, having origin in the kidney. Numerous intravenous urograms were done and no evidence of a renal tumor could be demonstrated.

On July 30, 1943, the lesion was again examined and it was felt that we were dealing in all probability with a primary bone sarcoma. The patient's pain recurred and he was referred to the Roentgen Therapy Department for treatment which was administered between January 5 and 27, 1944, 1,800 r (air) being delivered to each of two large 15×20 cm. fields covering the lesion. Three days after treatment was started it was noted that the patient still complained of pain, but on the twelfth day of therapy he stated he was definitely more comfortable. Amputation was done February 24, 1944. The specimen showed an infiltrating malignant tumor which was finally considered to be characteristic of metastatic adenocarcinoma, the primary site of which could not be determined. The patient was carefully followed, but even after review we were unable to show any evidence of a primary tumor in any other organ.

Following amputation the patient gained considerable weight and his general condition was better than any time since admission to the hospital. It was felt that he had received maximum benefit and he was given a Certificate of Disability Discharge, with a final diagnosis of carcinoma, scirrhus adeno, middle third—left femur. The final laboratory pathological report was as follows: "Metastatic scirrhus adenocarcinoma with unusually abundant osteoid stroma and dense involucrum formation" (Fig. 20).

It was felt the most likely possibility of the primary focus in the order of probability was (1) renal tumor, (2) body of pancreas, (3) stomach, (4) bronchus or (5) prostate.

Comment. This case is of interest because it shows the difficulties that are sometimes encountered as the result of insufficient biopsy

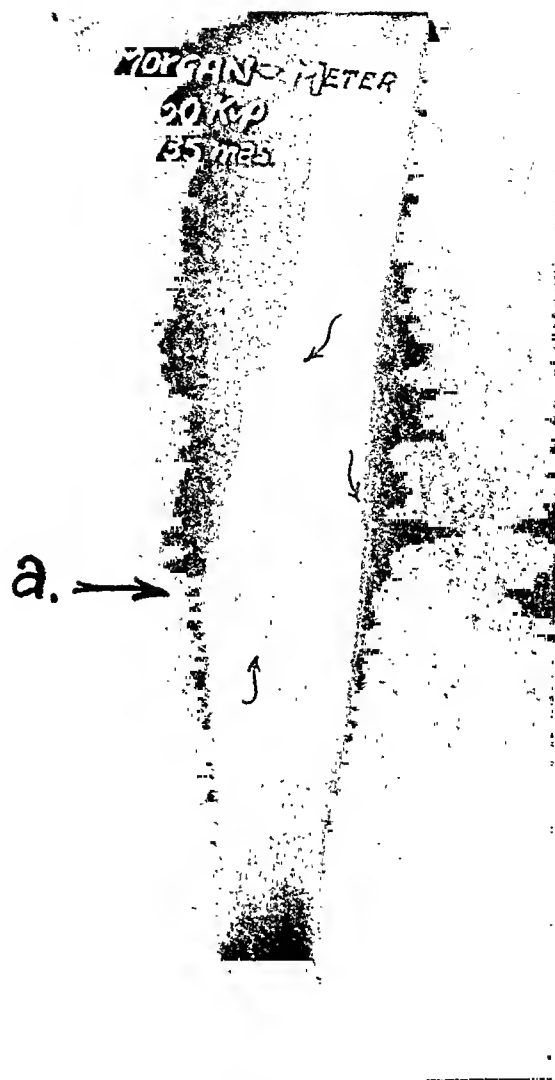


FIG. 20. Case VII. Tumor of the left femur, diagnosed as osteoid-osteoma on the basis of an incomplete histopathological section. This case responded to roentgen therapy after approximately twelve days' treatment. Roentgen diagnosis: malignant tumor of bone. Following amputation this proved to be "metastatic scirrhus adenocarcinoma" with unusually abundant osteoid. No primary source of the tumor could be found after careful investigation. Exposure determined by means of the Morgan meter.

material and the importance of the careful roentgen investigation which suggested the presence of malignant disease of bone.

It will be noted from the case reports presented, that roentgen therapy has been used as an adjuvant to orthopedic treatment in this hospital. We feel that bone sarcoma is primarily a surgical disease, and treatment by deep roentgen therapy alone is not warranted except in those cases where the lesion is inoperable or where the

patient refuses surgical treatment. It is difficult to escape the conclusions of Brunschwig and Tschetter³ that "... no tumor is surgically resistant, but there are many tumors that are radioresistant and radical removal should always be urged upon the patient first."

Certainly roentgen therapy must be individualized, but whether it is necessary to attain a maximum tissue dose of 4,500 r (air) as suggested by Swenson¹⁶ in his excellent article is problematical. Woodard and Higinbotham¹⁷ have pointed out that the phosphatase producing mechanism of most osteogenic tumors is inactivated by radiation therapy when the tissue dose is in the region of 4,000 r. One may be justly excused for speculating why osteogenic tumors considered highly radioresistant, except in children, should be inactivated at 4,000 r plus and why the relatively radiosensitive tumors such as Ewing's tumor should require a similar dosage, 4,500 r. Brunschwig and Tschetter have indicated that as high as 30 per cent of bone tumors can be inactivated (not cured) by dosages ranging between 2,400 r (air) delivered in six weeks to 13,000 r (air) over an interval of five and a half years.

The major problem, particularly in Ewing's tumor, is to prevent the appearance of chest metastases which usually make themselves manifest within two years of the time treatment is instituted. Woodard and Kenney¹⁸ have suggested the use of radioactive phosphorus as a method of inhibiting the implantation and growth of tumor emboli. It is possible that this treatment may play a very important rôle in the control of metastatic disease at the time when P³² again becomes available. It is possible also that some form of total body irradiation as advocated by Heublein⁸ or general therapy over the thorax carried out at long distance with low intensity over a period of days or weeks may control the appearance of metastases and improve the five year survival rate.

COMMENT

Despite its mimicries by other types of

small round cell malignant growths, Ewing's tumor remains a well defined clinical and pathological entity. Intermittent fever, bone pain, and localized swelling are its earlier clinical manifestations, frequently preceded by an incident of trauma. With the eventual development of a definite tumor mass the roentgenological appearance is distinctive and often permits diagnosis, particularly when confirmed by rapid subsidence of the tumor following radiation therapy. Histopathologically the tumor is also well defined and can ordinarily be diagnosed with reasonable assurance by any experienced pathologist. The cell type is distinguished by its lack of variation from its basic pattern even in its metastases, by the uniform clustering of cells into solid sheets without appreciable architecture except that provided by blood vessels or the framework of invaded tissues, by the paucity of mitoses or other "malignant" features seen in more anaplastic tumors, and by the delicacy of structure of the cell body and nucleus. All of these features suggest an embryonal type of tumor and point to the usefulness of employing this category of classification of tumors not only for Ewing's tumor, but for similar undifferentiated malignant growths which may imitate it, such as neuroblastoma of the adrenal medulla, seminoma of the testis, and certain others. The embryonal nature of the tumor and its predilection for the earlier age groups possibly reflect an underlying element of dysontogenesis, i.e. faulty development, in its etiology in accordance with the "embryonal rest" theory of tumor origin.

SUMMARY

1. Patients with bone tumors constitute a relatively high percentage of admissions to Percy Jones General Hospital. This is in part due to the age group with which we are dealing and in part to the fact that this is an Amputation and Deep Roentgen Therapy Center.

2. Roentgenographic examination is of inestimable value in the diagnosis of all types of bone tumors, including Ewing's

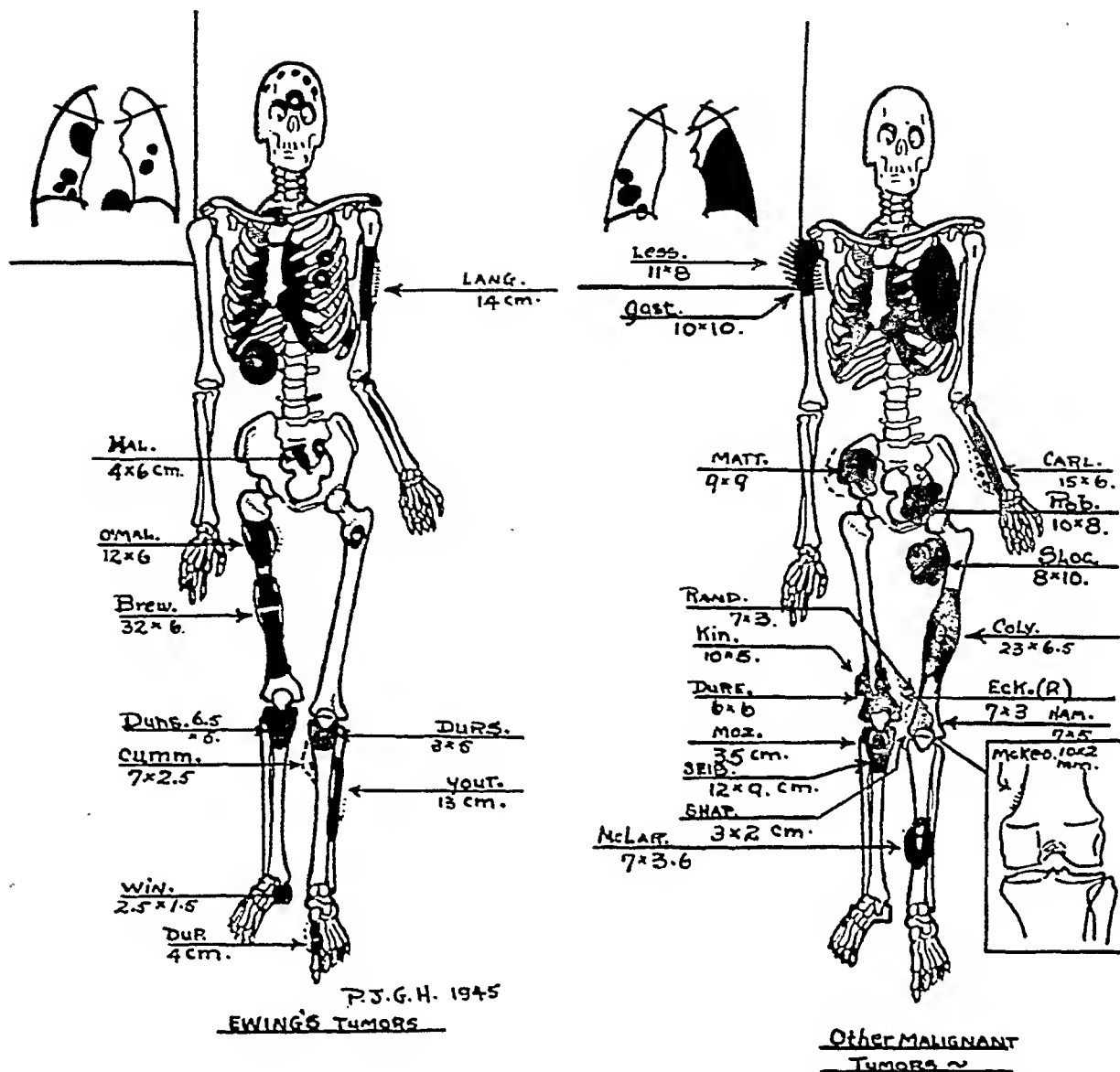


FIG. 21. Composite illustration showing sites of Ewing's tumors met with at Percy Jones General Hospital since January 15, 1943. The right hand illustration shows the other types of osteogenic tumors encountered. It will be noted that Ewing's sarcoma often involves a relatively long area of the shaft or may cause slight widening of the shaft simulating a nonsuppurative osteomyelitis. Insert on left shows metastatic mediastinal Ewing's tumor which arose from a soft tissue mass adjacent to the left internal tibial condyle (cumm. 7x2.5). Areas marked with small white centers indicate metastatic lesions in bones, liver and skull. Insert on right shows huge metastatic lesion involving left hemithorax mimicking a hydrothorax. Note the apparent predilection of the osteogenic tumors for the distal femoral and proximal tibial condyles. In our series we have not yet encountered Ewing's tumor of the distal femoral condyle.

sarcoma and a distinct aid in determining the time and site of biopsy.

3. Reference to Figure 21 will show the areas of skeletal involvement in most of the tumors of bone encountered at Percy Jones General Hospital during the preceding two and a half years.

4. Repeated roentgenographic examinations are essential in any case with symptoms suggesting early bone sarcoma. Small lytic lesions and slight periosteal reactions associated with tumors of the soft parts

should be regarded with concern in soldiers in the second and third decades. In suspected cases a therapeutic test of roentgen irradiation may be invaluable.

5. Judicious deep roentgen therapy is a useful adjunct to surgical treatment in the period prior to operation when the clinical findings are being reviewed and permission is being obtained for operation.

6. Regardless of the form of treatment, the prognosis in Ewing's tumor is grave. Six of ten of our patients are dead or dying

on an average of nineteen months after the onset of symptoms.

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REFERENCES

1. BARDEN, R. P. Similarity of clinical and roentgen findings in children with Ewing's sarcoma (endothelial myeloma) and sympathetic neuroblastoma. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 50, 575-581.
2. BRAILSFORD, J. F. Importance of radiology in early diagnosis of bone tumours. *Brit. J. Radiol.*, 1937, 10, 171-195.
3. BRUNSCHWIG, A., and TSCHETTER, D. Experiences in treatment of primary skeletal sarcoma by irradiation. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 44, 83-89.
4. CAMP, J. D., and GOOD, C. A., JR. Roentgenologic diagnosis of tumors involving the sacrum. *Radiology*, 1938, 31, 398-403.
5. CUTLER, M., BUSCHKE, F., and CANTRIL, S. T. Cancer: Its Diagnosis and Treatment. W. B. Saunders Co., Philadelphia, 1938, pp. 632-636.
6. EWING, J. Review and classification of bone carcinoma. *Arch. Surg.*, 1922, 4, 485-533.
7. EWING, J. Neoplastic Diseases. Fourth edition. W. B. Saunders Co., Philadelphia, 1940, pp. 306-308; 523-524.
8. HEUBLEIN, A. C. Preliminary report on continuous irradiation of entire body. *Radiology*, 1932, 18, 1051-1062.
9. KOLODNY, A. Bone sarcoma; primary malignant tumors of bone and giant cell tumor. *Surg., Gynec. & Obst.*, 1927, 44, 1-214.
10. MEYERDING, H. W., and VALLS, J. E. Primary malignant tumors of bone. *J.A.M.A.*, 1941, 117, 237-243.
11. NEELY, J. M., and ROGERS, F. T. Roentgenological and pathological considerations of Ewing's tumor of bone. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 43, 204-210.
12. PANCOAST, H. K., PENDERGRASS, E. P., and SCHAEFFER, J. P. The Head and Neck in Roentgen Diagnosis. Charles C Thomas, Springfield, Illinois, 1940, pp. 264-265.
13. RIGLER, L. G. Outline of Roentgen Diagnosis: An Orientation of the Basic Principles of Diagnosis by the Roentgen Method. J. B. Lippincott, Philadelphia, 1938, pp. 30-31.
14. STOUT, A. P. Discussion of pathology and histogenesis of Ewing's tumor of bone marrow. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 50, 334-342.
15. SUTHERLAND, C. G. Roentgenography in diag-

nosis of tumors of bone. *Med. Clin. North America*, 1941, 25, 1041-1065.

16. SWENSON, P. C. Roentgenologic aspects of Ewing's tumor of bone marrow. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 50, 343-354.
17. WOODARD, H. Q., and HIGINBOTHAM, N. L. Serum and tissue phosphatase determinations as aid in evaluating radiation therapy of bone tumors. *J.A.M.A.*, 1941, 116, 1621-1627.
18. WOODARD, H. Q., and KENNEY, J. M. Relation of phosphatase activity in bone tumors to deposition of radioactive phosphorus. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1942, 47, 227-239.

ADDITIONAL REFERENCES

- BUDD, J. W., and MACDONALD, I. Modified classification of bone tumors. *Radiology*, 1943, 40, 586-588.
- DE SANTO, D. A., and BURGESS, E. Primary and secondary neurilemmoma of bone. *Surg., Gynec. & Obst.*, 1940, 71, 454-461.
- EWING, J. Review of classification of bone tumors. *Surg., Gynec. & Obst.*, 1939, 68, 971-976.
- FERGUSON, A. B. Treatment of osteogenic sarcoma. *J. Bone & Joint Surg.*, 1940, 22, 92-96.
- GHORMLEY, R. K., and POLLOCK, G. A. Multiple myeloma. *Surg., Gynec. & Obst.*, 1939, 69, 648-655.
- GHORMLEY, R. K., POLLOCK, G. A., HALL, B. E., and BEIZER, L. H. Multiple myeloma. *Surg., Gynec. & Obst.*, 1942, 74, 242-244.
- HOWES, W. E., and SCHENCK, S. G. Roentgenological considerations in diagnosis and treatment of primary malignant bone tumors. *Radiology*, 1941, 37, 18-34.
- MACDONALD, I., and BUDD, J. W. Osteogenic sarcoma; modified nomenclature and review of 118 five year cures. *Surg., Gynec. & Obst.*, 1943, 77, 413-421.
- MAYER, L., and FRIEDMAN, M. Extraskelatal bone-forming tumor of the fascia, resembling osteogenic sarcoma. *Bull. Hosp. Joint Dis.*, 1941, 2, 187-192.
- MEYERDING, H. W. Classification of bone tumors. *Proc. Staff Meet., Mayo Clin.*, 1943, 18, 17-18.
- MEYERDING, H. W., and POLLOCK, G. A. Ewing's tumor (hemangio-endothelioma; endothelial myeloma; solitary diffuse endothelioma); problem in differential diagnosis. *Minnesota Med.*, 1940, 23, 416-423.
- PIKE, M. M. Paget's disease with associated osteogenic sarcoma. *Arch. Surg.*, 1943, 46, 750-754.
- SIMMONS, C. C. Bone sarcoma. *Surg., Gynec. & Obst.*, 1939, 68, 67-75.
- SIMMONS, C. C. Tumors of bone. *New England J. Med.*, 1939, 220, 629-632.

FIBROUS DYSPLASIA OF BONE*

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THE disease entity, fibrous dysplasia of the skeleton, has been generally recognized only since 1937. This recognition was, for the most part, the result of contributions to the literature by Albright and co-workers¹ and Lichtenstein.⁵ Furst and Shapiro³ showed in their review of the literature that this disease was known as early as 1922 but was described under various other titles such as "osteitis fibrosa cystica congenita" "precocious puberty and bone brittleness," and so forth. A survey of reported cases of fibrous dysplasia of bone was made by Lichtenstein and Jaffe⁶ in 1942. They found that 75 cases of this disease were recorded in the literature. To this number, they added an additional 15 cases. Recently Dockerty and associates² described a series of cases all of which had bone lesions and extraskeletal changes including cutaneous pigmentations, somatic precocity in both sexes, and gonadal dysfunction in females. In their review of the literature, they did not include cases with only bone lesions and thus divided this disease into two types. In the case to be described no extraskeletal lesions were found.

The etiology of this disease is obscure. The prevailing opinion is that it is due to a developmental defect. It is characteristically discovered in childhood or early adolescence. A pathological fracture may be the first indication of the disease, or a limp with pain or deformity of the lower limbs may be the chief complaint. Facial asymmetry, ocular proptosis, and acromegalic changes may occur at times. The extraskeletal abnormalities are pigmentation of the skin; sexual precocity and endocrine dysfunction in female patients mainly, and hyperthyroidism. Dockerty and associates

believe that somatic precocity may occur in both sexes.

Laboratory examinations are frequently negative in this disease. The blood phosphatase, however, may be elevated. In our case, we found a consistently elevated blood urea ranging between 44 and 48 mg. per 100 cc. However, we do not know whether this is of significance in relation to this disease.

One or many of the bones may be involved. Roentgenological studies, as Lichtenstein and Jaffe⁶ point out, show the distribution of bone lesions to be predominantly unilateral. The characteristic lesions are scattered areas of rarefaction which have the appearance of bone cysts varying in size and shape. However, areas of increased density and overgrowth of bone are also found. Roentgen examination of lesions of the long bones show the cortex to be thinned and the medullary space to be distended. Frequently bowing of the long bones and coxa vara are present. Albright, in discussing Kornblum's paper⁴ states that the roentgen examination seldom, if ever, shows involvement of the epiphyses in this disease. However, Dockerty and associates believe that early epiphyseal union and advanced bone age are found at times. In this patient the epiphyseal development and absence of epiphyseal union indicate normal bone age.

The main pathological findings in this disease have been well described by Lichtenstein and Jaffe.⁶ The findings in our case are similar to theirs and those of other reported cases. Although the histopathological picture is not entirely characteristic, a biopsy is of aid and should be performed, if possible, in all cases where this disease is suspected.

It seems evident that although fibrous

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dysplasia has been looked upon as a cystic bone disease, cysts if present are an insignificant and secondary part of the lesion. The rarefied areas in the bone are ordinarily solid lesions, composed of collagenous connective tissue in which there may be small foci of ossification. In the main, the areas of bone show little osteoblastic activity. They are thought to represent metaplasia from the connective tissue. The calcification may be irregular, but in our case was fairly uniform. Occasionally, metaplastic foci of cartilage have also been found. Cysts, when present, are apparently the result of degeneration, necrosis or hemorrhage. Only insignificant numbers of lymphocytes are present; consequently the lesions are evidently not due to inflammation. No evidence of neoplasm has been found in any of the cases.

Fibrous dysplasia of bone has been found to be a self-limited disease. The activity of the disease process decreases with advancing age and is quiescent in adults. There is no therapy indicated in this disease except occasional bone curettage or rib resection of monostotic lesions. It may rarely be advisable to perform massive autogenous bone grafts to strengthen long bones which have undergone pathological fractures or are in danger of doing so. Generally, however, conservative treatment of these cases with proper caution against trauma and severe exercise in an effort to avoid spontaneous fractures is advisable.

CASE REPORT*

W. L., male, white, aged eleven, was admitted to St. Alexis Hospital on May 11, 1944, because of a limp which was noticed by his gymnasium instructor about February 1, 1944. The boy was well until four years ago, at which time he fell from a garage roof and suffered a fracture of the shaft of the right femur. He was in the hospital for thirty-five days and wore a cast for seven weeks. Following this fracture, he developed a slight limp which became progres-

sively worse. Two years ago, he fell and fractured his right forearm and one year ago fractured the left forearm. Past history revealed that the child had the usual childhood diseases, including measles, chickenpox, whooping cough, and scarlet fever. There was no familial history of bone disease. The boy's paternal grandfather died of pulmonary tuberculosis. The father and mother are alive and well. The patient's two year old brother has had no serious illnesses. The developmental history disclosed that the patient was a full term normal infant weighing 5 pounds 4 ounces at birth. The Wassermann reaction was negative at birth. He was breast fed for three and a half months, and then alternated on S.M.A., evaporated milk, and grade A milk. He received no liver, vegetables, or juices until four years of age and was never given cod liver oil. He received ample air and sunlight. He was always undernourished and short of stature for his age. The mental development was normal; he sat up at nine months, stood up at ten months, and walked and talked at the age of one year. Smallpox vaccination and diphtheria toxoid inoculation were done when the boy was fifteen months old. Mantoux and Schick tests were negative at six years of age.

Physical examination revealed a fairly well developed boy who appeared to be about nine years of age and walked with a limp. He measured 4 feet 5½ inches in height. The parietal bones of the skull were more prominent than usual. The eyes, ears, nose, and throat showed nothing abnormal. The chest was normal in shape and there was good expansion. The lungs were clear to percussion and auscultation. The heart was normal in size, rhythm was regular, and the rate was 80 per minute. No abnormal cardiac sounds were heard. There were neither palpable masses nor tenderness in the abdomen. There was no pain or limitation of motion in any of the extremities. The left leg showed some atrophy of the thigh and measured 66 cm. from the anterior superior spine to the internal malleolus. The right leg measured 67 cm. using the same topographical landmarks.

Laboratory Findings. The urine revealed nothing abnormal. Urine examination for Bence-Jones protein was negative. There was no increase in urinary calcium excretion. Examination of the blood revealed the erythrocyte count to be 4,890,000, with 12.8 grams of hemoglobin per 100 cc. The leukocyte count

* We wish to thank Dr. R. J. Stasny for permission to report this case.

FIG. 2. May 13, 1944. Typical lesions of bones of the skull, involving especially the bones of the left side of the vault and base.

was 8,200, with 66 per cent polymorphonuclears, 32 per cent lymphocytes, and 2 per cent eosinophiles. The sedimentation rate was 5 mm. per hour. The blood sugar was 106 mg. per 100 cc. Repeated blood urea determinations varied from 43 to 48 mg. per 100 cc., and the creatinine ranged from 2.4 to 3.55 mg. per 100 cc. The

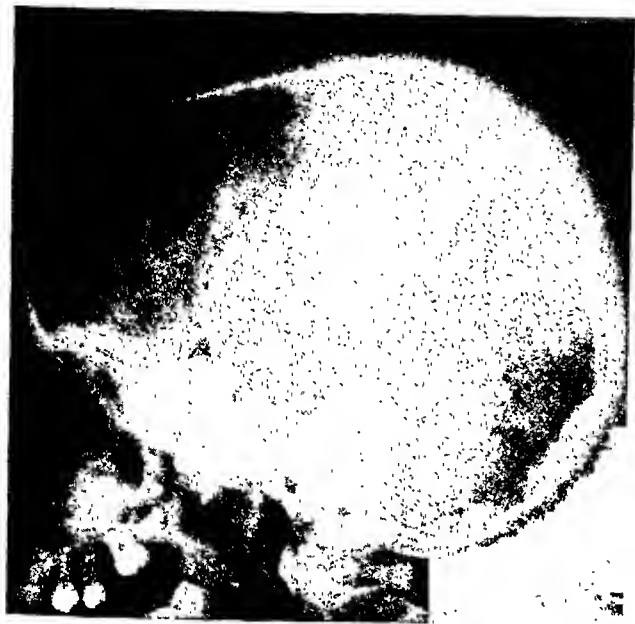


FIG. 1. May 13, 1944. Lateral view of skull showing thickening of occipital and basal bones and focal rarefied areas.

blood phosphatase was 5.28 Bodansky units. A blood Kline test was negative.

Roentgenologic Findings. The skull had a most unusual appearance (Fig. 1 and 2). There was marked thickening of the occipital and left parietal bones. The bones of the base of the skull in the anterior and middle fossa were thickened and showed marked increase in their density. There were numerous small, round, sharply defined areas of decreased density in the bones of the vault of the skull. The clinoid processes of the sella turcica were large and dense, especially the anterior. There was

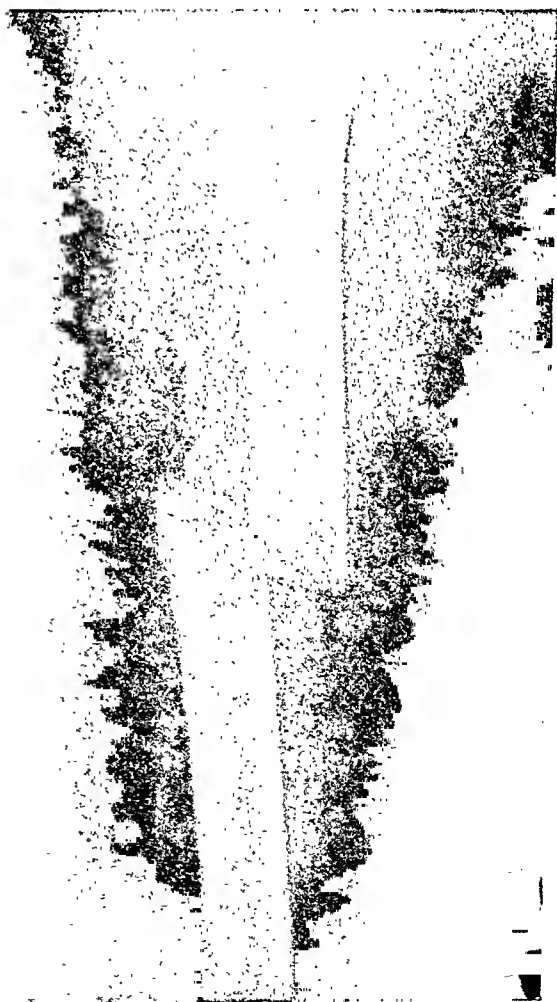
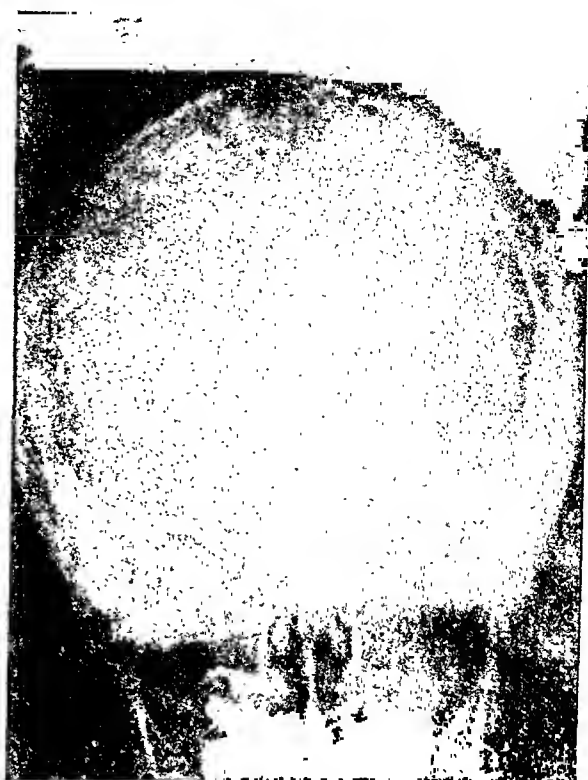


FIG. 3. July 9, 1940. Pathological fracture of the right femur through the lesion at the site of fracture. Second lesion in upper fragment of the femur above the site of fracture.



FIG. 4. April 23, 1944. Typical lesions involving the bones of the pelvis and upper portion of both femurs.

sclerosis of the left mastoid process. The right femur (Fig. 3) had a healed pathological fracture of the middle third of the shaft of the femur through a small cyst-like area. (Fig. 3

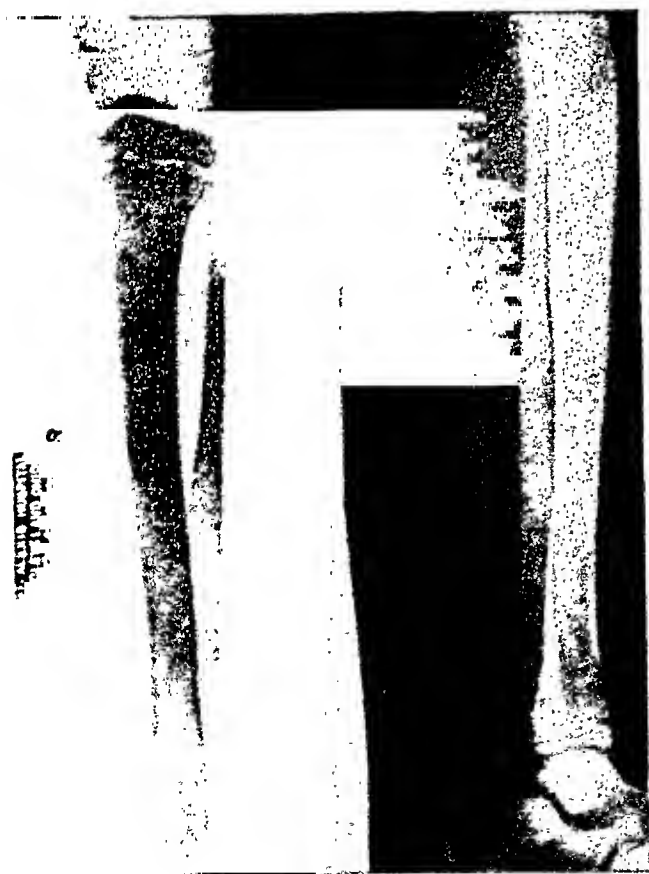


FIG. 5. May 16, 1944. Typical lesions involving the bones of the left leg.

shows the original fracture with rarefied area.) There was a larger rarefied area about an inch and a half long and three-quarters of an inch wide in the upper third of the shaft of the femur just below the level of the lesser trochanter. The medullary space here was widened and the cortex was thin. The pelvis (Fig. 4) contained numerous areas of decreased density most marked on the left, which appeared cystic.



FIG. 6. Photomicrograph ($\times 134$) showing typical area from tibia. The bony trabeculae are fairly prominent. The fibrous tissue shows various degrees of cellularity.

The left side of the pelvis was slightly deformed and deviated a little toward the midline. There was decreased density in the neck and upper portion of the left femur. The upper end of the left femur showed marked deformity with lateral bowing of the shaft. The chest showed slight enlargement of the right fifth and left fifth and seventh ribs. In the left leg (Fig. 5) there were marked changes in the bone structure of the tibia, fibula and os calcis. There were areas of decreased density throughout the shaft of the tibia and in the lower two-thirds of the shaft of the fibula. There was moderate widening of the shaft of the tibia and fibula in the involved regions and the cortex was thin.

Pathological Findings. A biopsy was taken from the shaft of the left tibia. No cyst was identified. The gross specimen consisted of irregular bony fragments varying from 2 to 10 mm. in diameter. Most of the fragments were porous resembling cancellous bone, but the largest contained some dense, bony tissue resembling cortex. The tissue was fixed in Zenker's fluid.

Histologic sections revealed abnormal bony tissue and no distinction as to compact or cancellous layers could be made. No regular concentric bony lamellae were seen. The basic structure was collagenous connective tissue in which islands of bone were present. These varied in size and contour, and were irregularly distributed in the stroma. Although there was variation in the amount of bone, no areas were found in which the bone occupied less than approximately one-fifth of the total sectioned surface. For the most part, the masses were well calcified. The lacunar cells were of average appearance. There were occasional osteoblasts at the periphery of the masses but only few osteoclasts were noted. The ströma was composed of collagenous connective tissue in which the nuclei were considerable in number. Most of the nuclei were oval and vesicular, but others were narrow and dense. There was moderate vascularity. The capillary walls were thin and the lumens were filled with blood. The extravascular blood cells were presumed to be artefacts. Only an occasional lymphocyte and plasma cell was noted in the stroma. No cartilage was identified (Fig. 6).*

SUMMARY

A case of fibrous dysplasia of bone showing polyostotic involvement and unilateral thickening of the skull has been presented. There were no extraskeletal abnormalities. The clinical, roentgenographic

and histopathologic aspects of this disease are discussed.

It has been shown that there are four salient features of this disease which must be regarded as the criteria for diagnosis. They are as follows:

1. The clinical syndrome manifested by onset of symptoms in childhood with ultimate local pain, deformity and disability of some extremity.
2. Roentgenographic evidence showing characteristic skeletal involvement of one or many bones, with a strong tendency to be unilateral.
3. Blood chemistry and urine studies which show absence of the results characteristic of other disease of the skeleton. The blood phosphatase is often moderately elevated.
4. Bone biopsy which shows a consistent histopathological picture.

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REFERENCES

1. ALBRIGHT, F., BUTLER, A. M., HAMPTON, A. O., and SMITH, P. Syndrome characterized by osteitis fibrosa disseminata, areas of pigmentation and endocrine dysfunction, with precocious puberty in females. *New England J. Med.*, 1937, 216, 727-746.
2. DOCKERTY, M. B., GHORMLEY, R. K., KENNEDY, R. L. J., and PUGH, D. G. Albright's syndrome (polyostotic fibrous dysplasia with cutaneous pigmentation in both sexes and gonadal dysfunction in females). *Arch. Int. Med.*, 1945, 75, 357-375.
3. FURST, N. J., and SHAPIRO, R. Polyostotic fibrous dysplasia; review of literature with 2 additional cases. *Radiology*, 1943, 40, 501-515.
4. KORNBLUM, K. Polyostotic fibrous dysplasia. *Am. J. Roentgenol. & Rad. Therapy*, 1941, 46, 145-159.
5. LICHTENSTEIN, L. Polyostotic fibrous dysplasia. *Arch. Surg.*, 1938, 36, 874-898.
6. LICHTENSTEIN, L., and JAFFE, H. L. Fibrous dysplasia of bone. *Arch. Path.*, 1942, 33, 777-816.

* We wish to acknowledge that the roentgenograms and histologic preparations were examined by Drs. L. Lichtenstein and H. L. Jaffe who concurred in our diagnosis.



PARA-ARTICULAR CALCIFICATION IN THE LOWER EXTREMITIES OF PARAPLEGIC PATIENTS*†

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CALCIFICATION about the joints and in the soft tissues of the lower extremities of paraplegic patients has been reported rather infrequently. Derra and Nadermann¹ recently reported 2 cases and discussed the incidence and etiology. They reviewed many of the previous reports, mainly from the European literature, and found that the condition had been present in many of the veterans of World War I who had sustained spinal cord injuries. Some of the reports cited by these writers gave the incidence as high as 50 per cent for soft tissue calcification in the lower extremities of paraplegics. The etiology was admittedly uncertain, however they believed that it was in some manner related to irritative neural impulses following spinal cord injuries.

At this hospital 88 patients with spinal cord and cauda equina injuries of varying severity were observed during a two year period. Many of the early cases were retained at this installation only a short time and roentgenograms of the lower extremities were not obtained. Thirty-three patients were observed over a longer period of time; para-articular and soft tissue calcification in the lower extremities was observed in 4 cases. Only those cases that had swelling or stiffness of the joints were completely studied by roentgenograms, so the true incidence cannot be estimated. Three of these cases had only a minor degree of calcification in the soft tissues about the knee joints; the fourth case, however, had very extensive calcification about the knees and in the soft tissues of the lower thighs, and is presented here in detail.

CASE REPORT

A twenty-six year old American soldier sus-

tained a small shell fragment wound of the spine at the level of the tenth thoracic vertebra on November 18, 1944. On November 19, 1944, a lumbar puncture was done below the site of injury and revealed a complete block of spinal fluid. Laminectomy was not done. During the month of December, 1944, while being evacuated to the United States, the patient rapidly lost weight and developed large decubitus ulcerations over both hips and the sacrum. He developed massive edema of both lower extremities about one week after injury. He arrived at this hospital on January 17, 1945. There had been no improvement in paralysis or anesthesia below the level of injury.

Physical examination on admission to this hospital revealed an extremely pale and chronically ill patient. There were large decubitus ulcers over both hips, heels, and the sacrum. There was a small well healed wound, measuring 1 cm. in diameter, just to the left of the spinous process of the tenth thoracic vertebra. There was complete anesthesia and flaccid paralysis below the eleventh thoracic segment of the spinal cord. There was marked pitting edema of both lower extremities from the toes to the groins. The red blood cell count was 2 million; the hemoglobin was 6.5 grams per 100 cc.

On January 31, 1945, roentgenograms of the lower extremities revealed extensive calcification in the soft tissue about both knee joints (Fig. 1). On February 24, 1945, a lumbar puncture revealed a complete manometric block. Supportive treatment with transfusions and proper diet resulted in marked improvement in the patient's general condition. In March, 1945, the edema of the lower extremities was negligible; a roentgenogram at this time revealed further extension of the calcification about the knees (Fig. 2). During April, 1945, the patient developed an extension of the infection from the decubitus ulcer over the left hip into the left thigh, and this required incision and drainage. During the next few months the patient's general condition rapidly improved and he was able

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to be up in a wheel chair. There was only 30 degrees of motion at the knee joints, and leg supports were required. In August, 1945, a skin graft was applied to the sacral ulceration which resulted in complete healing. By October, 1945, the decubitus ulcerations over the trochanters were healed; roentgenograms of the right hip revealed some fragmentation of the articulating surface of the head of the femur with marked para-articular calcification (Fig. 3). Fine granular deposits of calcium had been noted about this joint in May, 1945. Roentgenograms of the knees revealed essentially the same amount of calcification as had been noted in March, 1945.



FIG. 1. Roentgenogram of the right and left knees approximately two and a half months after injury. Para-articular calcification is already marked.

The patient was transferred to another hospital in February, 1946, at which time his general condition was excellent and he was beginning the use of braces and crutches for ambulation.

The consensus is that the calcification about the joints and in the soft tissues usually begins during the first year after the spinal cord injury, if it is to develop. In the cases studied, those that did not have calcification about the joints when roentgenograms were taken six months after injury did not subsequently develop any significant amount of soft tissue calcification, except in those cases that had late associated fractures. This extensive para-articular calcification associated with late fractures of the neck of the femur has been observed in 2 of the paraplegic



FIG. 2. Roentgenograms of right and left knees approximately four and a half months after injury. Increased calcification is evident.

patients. In the case reported in detail, it was noted following fragmentation of the



FIG. 3. Roentgenogram of right hip showing para-articular calcification. Fragmentation of articulating surface and a large decubitus ulcer (now healed) over trochanter contributed to its development.

articulating surface of the head of the femur. Lesser amounts of calcification in the soft tissue about the upper end of the femur and hip joints have been observed in those cases that had extensive decubitus ulcers over the trochanter.

The cause of the calcification is not certain. It is generally known that calcification occurs not infrequently in muscles adjacent to fractures, hematomas, areas of fatty necrosis and in irritated bursae. Many theories have been advanced to explain the development of this calcification. Piatt³ observed calcification about the ankle joint and believed that multiple repeated minor traumatism were predisposing factors. Nachlas and Olpp² in an investigation of para-articular calcification (Pellegrini-Stieda's disease) about the knee believe that it begins as the result of a series of small traumas which do not attract much attention and is followed by degenerative changes in the gliding membrane over the adductor tubercle. Minor incomplete lacerations occur in the altered tissues with small localized areas of bleeding, which under proper physical and chemical conditions lead to calcification. The stiffness and fixation of connective tissue structures about joints following immobilization is frequently observed and is accentuated when edema is or has been present. The paraplegic patient may present several conditions that predispose to the development of soft tissue calcification in the lower extremities. Edema of the lower extremities is a fairly frequent finding shortly after a spinal cord injury and is accounted for by several factors which include immobilization, vasomotor relaxation and nutritional hypoproteinemia. At times the edema may be massive and the lower extremities are swollen tense with a shiny pale surface. Persistence of the edema leads to fixation of organic compounds in the connective tissue structures rendering them susceptible to calcifications, or to repeated trauma. The process of attrition in the connective tissue structures about

the joints may be accentuated by the slowing of venous return from the extremities incident to the flaccid paralysis.

The cases that have been observed to have even minor degrees of soft tissue and para-articular calcification have had massive edema of the lower extremities at some time after the spinal cord injury. These patients have usually had a complete flaccid paralysis. Shortly after the spinal cord injury there is a rapid demineralization of the bones of the lower extremities associated with a hypercalcinuria. It is difficult to know what part this rapid movement of calcium plays in the development of the soft tissue calcification, but it would appear that if predisposing conditions of the soft tissues are present the incidence and degree of its occurrence might be influenced by the presence of large amounts of mobilized calcium from the bones. The addition of repeated minor traumas to the connective tissue structures with degenerative changes may well result in further attrition and localized areas of hemorrhages, leading to calcification. The calcification about areas of fractures that have occurred late after injury is certainly related to trauma and hemorrhage into the soft tissue.

The lesser degrees of para-articular calcification (Fig. 4 and 5) do not interfere with the rehabilitation of the paraplegic patients. On the other hand, extensive calcification about the knees may so limit flexion that these patients are not able to sit up in a wheel chair or on the side of the bed unless supports for the legs are provided. Such patients have difficulty in dressing themselves and cannot use the ordinary folding wheel chair on which the leg supports are not adjustable. Calcifications about the hip joints are subjected to repeated trauma and may eventually limit motion to such an extent that sitting up is difficult. The extensive calcification and deformity that results from a fracture of the neck of the femur may prevent satisfactory rehabilitation. One patient has been ob-



FIG. 4. Lesser degree of soft tissue calcification along medial epicondyle in a patient with paraplegia.



FIG. 5. Lateral view of the knee shown in Figure 4 with calcification in patella tendon.

served who sustained a fracture of the neck of the femur when turning in bed. The fracture was not recognized for several weeks; the extensive calcification and deformity that has resulted prevents the patient from sitting up or beginning the use of braces. An extensive calcification about the knees is compatible with use of braces for ambulation.

There is no treatment recommended for extensive soft tissue and para-articular calcification. Prevention of fractures or chipping of articular surfaces resulting from too vigorous efforts at rehabilitation should be emphasized.

At installations where large numbers of paraplegic patients are to be cared for a study of the incidence and etiological factors may yield further information on this condition.

SUMMARY

1. A case of extensive para-articular calcification in the lower extremities of a paraplegic patient has been presented.
2. A short discussion of possible etiological factors is given.

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REFERENCES

1. DERRA, E., and NADERMANN, E. Parossale Verkalkungen an den Beinen bei Paraplegikern nach Wirbelbrüchen. *Zentralbl. f. Chir.*, 1942, 69, 758.
2. NACHLAS, I. W., and OLPP, J. L. Para-articular calcification (Pellegrini-Stieda) in affections of the knee. *Surg., Gynec. & Obst.*, 1945, 81, 206-212.
3. PIATT, A. D. Post-traumatic para-articular calcifications and ossifications of the ankle. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 54, 348-354.

REVISED "OSSIFICATION INDEX" FOR THE DETECTION OF ENDOCRINE DISORDERS IN CHILDHOOD*

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THE use of an "ossification index" has been proposed in an effort to provide a quick, convenient and graphic scheme for indexing the advance of carpal ossification visualized in a roentgenogram taken for the study of skeletal progress in a growing child.⁴ As explained in the original presentation, gross divergence from the normal may be thereby promptly detected and completely recorded. It is admittedly true that the entire answer to any question of "bone age" or "rate of ossification" will have to be sought in studies beyond the limited inspection of the region of the wrist. It is also quite possible that an index based upon an assignment of figures for the approximate *average* rather than the *latest limit* of age for normal appearance would have considerable value. It has, nevertheless, been thought best to present the *standard* "ossification index" as the one based upon figures which represent the ages for the latest normal appearance and to rely upon the suggested, more or less automatic interpretation to answer the most frequently asked question—whether or not the start of ossification in the bone centers of the specific child has been abnormally delayed.

ROUTINE USE OF THE "OSSIFICATION INDEX"

When the figures are posted from a roentgenogram and a center is found absent whose assigned figure is less than the actual age of the patient, the validity of the automatic conclusion that abnormal delay in the ossification has occurred depends upon the correctness of the ages chosen for the limits of normal. As stated, these figures have been obtained from a tabulation of ages quoted from as many studies as could be readily found in the literature.⁴ Even so, it is suspected that some of these

writers are quoting other authors so that the actual number of independent observations of the normal may be more limited than it seems. However, there is a general agreement among these authorities, and, for us, the use of the set of figures chosen by inspection of this tabulation has shown, with a single exception, that the originally proposed standard "ossification index" correctly expresses for each bone the true outside limit of slow normal. The observation of the one exception has resulted in a change of the age limit or appearance of ossification in the distal ulnar epiphysis from the seventh to the eighth year. The standard "ossification index" for the full complement of carpal bones at the age of eight has therefore been revised to read 8-67-2456778 (Fig. 1).

Posting of the actual "ossification index" for each child in these age groups admitted to the Mary McClellan Hospital for such things as appendectomy, tonsillectomy and orthopedic surgery as well as those seen in the weekly well-baby clinic has seemed a logical way to study the progress of ossification in a cross section of the child population (Fig. 2). For this study, a portable roentgen-ray unit was set up and kept ready so that the taking of the desired roentgenogram consumed less than a minute of clinic time (Fig. 3). Very useful was the improvised frame in which an 8 by 10 inch cardboard film holder was placed to mask one-half of the film and properly superimpose the identifying marker on the margin of the other half just above the patient's hand (Fig. 4). Cardboard film holders were chosen because the disadvantages of longer exposure seemed to be offset by the practicability of having quite a number of holders loaded and ready. A special felt-padded board was also contrived to hold the infant's hand against the

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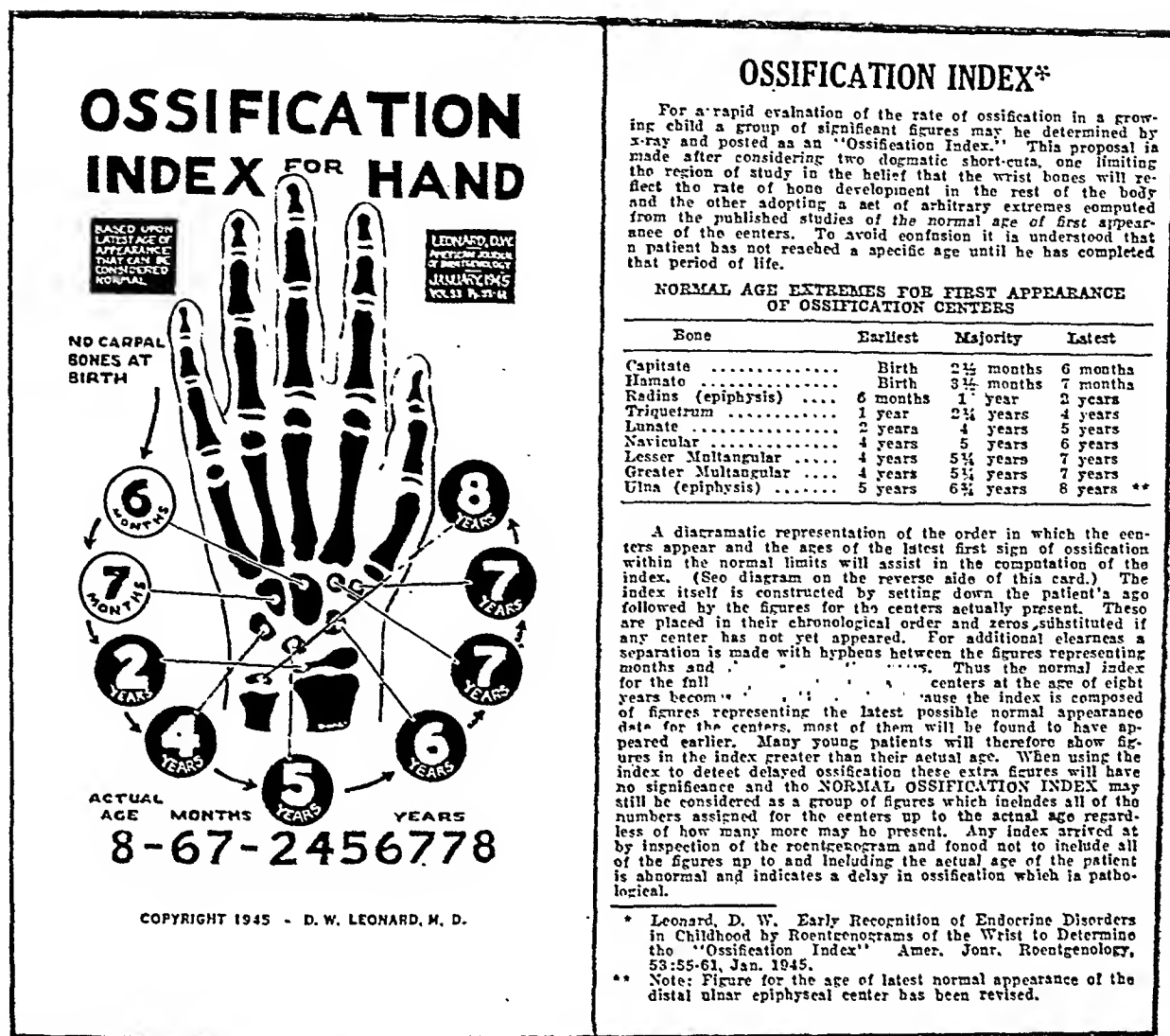


FIG. 1. Facsimile of both sides of a card ($3\frac{1}{2}$ by $6\frac{1}{4}$ inches) prepared for convenient determination of the "ossification index" from any roentgenogram of the carpal bones as suggested in a previous publication.⁴ Explanation of the method printed on the card includes a table of extremes for comparison.

film and with this it was found that a fairly satisfactory roentgenogram could be taken even with a struggling infant.

As the routine progressed and the graphic tabulation began, it was discovered that comparative results could only be obtained if the ages were expressed uniformly. For this reason it was decided that a child would be considered the age of his last birthday until he had completed another full year. The roentgen negatives of patients below the age of one year were marked by the number of weeks since birth and this figure was later converted into months according to the following schedule:

0 to 4 wk.	Condition at birth
5 to 8 wk.	1 mo. old
9 to 12 wk.	2 mo. old

13 to 16 wk.	3 mo. old
17 to 20 wk.	4 mo. old
21 to 25 wk.	5 mo. old
26 to 30 wk.	6 mo. old
31 to 34 wk.	7 mo. old
35 to 38 wk.	8 mo. old
39 to 43 wk.	9 mo. old
44 to 47 wk.	10 mo. old
48 to 51 wk.	11 mo. old.

By this study of the bone development in the wrist using the standard "ossification index" it has been sufficiently demonstrated that few clinically normal children will be incorrectly designated as abnormal in ossification. This study, therefore, becomes a successful test of the suggested "automatic interpretation" based upon the presence or absence of centers in relation to the actual age. Some objection may be

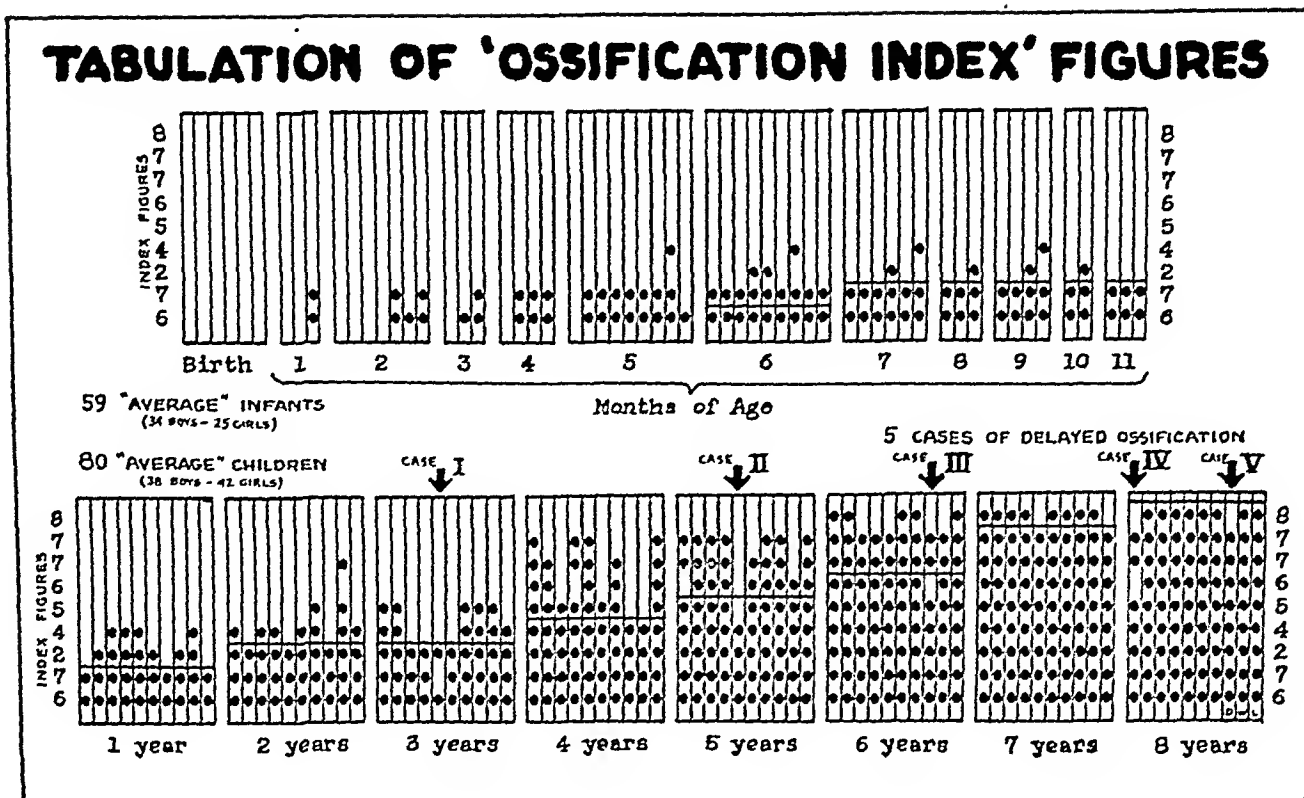


FIG. 2. Graphic summary obtained by plotting the actual "ossification index" for each of 59 infants and 80 children up to eight years of age. These indexes were obtained from average children without plan other than that of securing 10 of each age after the first year. The bones of the wrist have been numbered with the latest age of normal first appearance and plotted upward so that reading the vertical column in each case gives the "ossification index." The horizontal line in each age group indicates the level which should be reached at that age and all cases whose spaces are filled below that level are normal. Inspection of the result demonstrates 5 abnormal cases. These are all boys and may be described as follows:

Case I. W.E.S., male, aged three. Index: 3-60-2000000. Diagnosis: recurrent congenital clubfoot, bilateral. Ossification also delayed in feet. (Case included in series discussed *J. Pediat.*, 1945, 26, 379.)

Case II. R.F., male, aged five. Index: 5-67-2400000. Diagnosis: subacute appendicitis. Operation done with normal recovery. No history of subnormal development.

Case III. E.C.R., male, aged six. Index: 6-67-2450770. Diagnosis: hypertrophied tonsils and adenoids. Operation done with normal recovery. No history of subnormal development.

Case IV. H.R.N., male, aged eight. Index: 8-67-2450770 (both wrists). Diagnosis: dislocation of epiphysis, right radius. Colle's fracture of left radius. Fractures reduced and immobilized. No history of subnormal development or evidence of pathological fracture.

Case V. G.E.S., male, aged eight. Index: 8-67-2456770 (right hand) 8-67-2456778 (left hand). Diagnosis: scar of burn and flexion deformity of right hand; hypertrophied tonsils and adenoids. Operation done to remove tonsils and a skin graft done on the right hand. No history of subnormal development.

raised to the practice of placing the latest age limits so far beyond the averages or to the expression of the ages themselves in round numbers. It may also be said that the limits have been pushed so far that borderline cases of delayed ossification will be missed. It will, nevertheless, have to be admitted that there is definite virtue in the fact that when delay is indicated by the "index," it can be accepted as unmistakably abnormal. By reference to a table of earliest and average as well as latest age of appearance, an "index" which is normal

by the rule can still tell the examiner a good deal about minor variations, and if taken at the right moment (as would be necessary by any standard) the "index" can show disturbances in the normal order of appearance of the centers in the disharmonic development stressed by some writers. All of these things can be read from the figures of the "ossification index" in addition to the making of the survey for missing centers.

The data obtained by indexing the unselected cross section of the child population, as described, have been analyzed

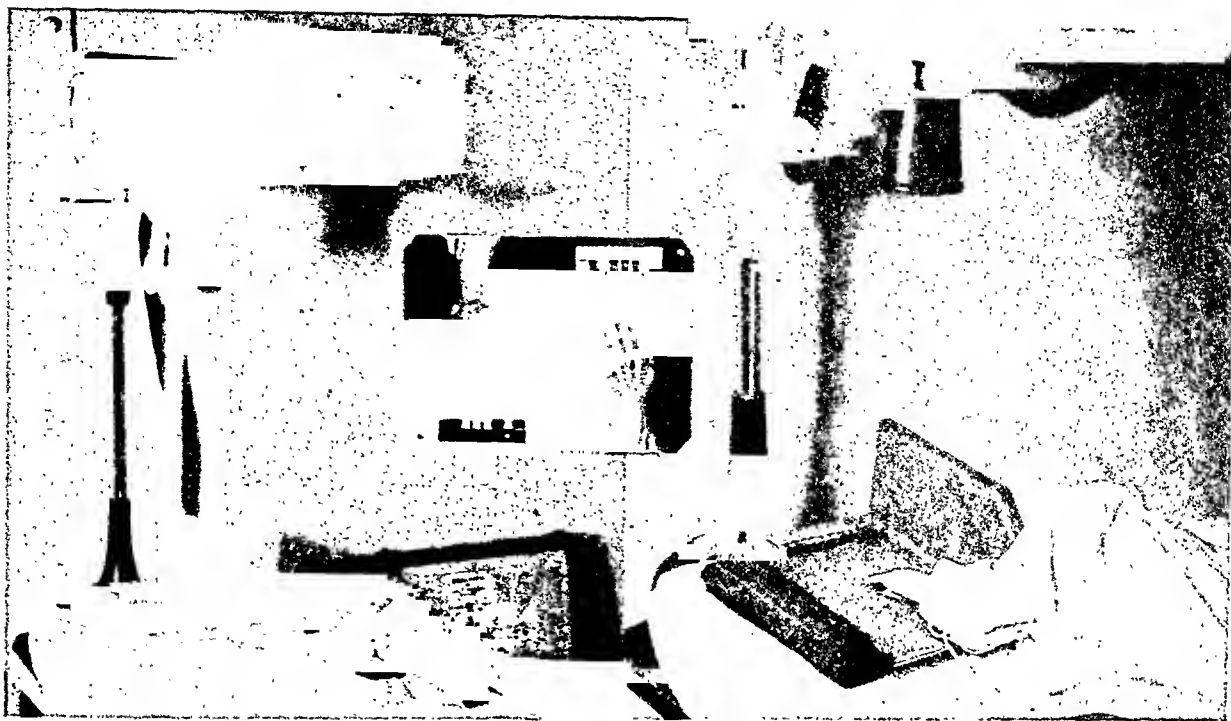


FIG. 3. Portable roentgen-ray unit set up for the clinic roentgen examinations necessary to determine the "ossification index." Cone on roentgen tube limits the field of exposure to a circle which just covers half of an 8 by 10 inch film. Centering is done by aligning the hand with the supporting post. An infant may be placed face down, as illustrated, with the head out of the field behind the upright portion of the film holder and older children may stand beside the table.

graphically (Fig. 2), and from the uniformity of the grouping it can reasonably be assumed that conclusions from this relatively small series are reliable.

INTERPRETATION OF THE "OSSIFICATION INDEX"

From several sources has come the comment that the use of the word "index" for this listing of the ages assigned to the centers is misleading. The term, of course, has been correctly defined as a figure obtained by the reduction of a fraction representing the ratio between what is normal and what is actually present. At the same time the word "index" has also correctly been defined as a list of several items in an arrangement for easy reference. This last conception is the one which led to the introduction of the term "ossification index" and it is believed that no other designation will serve as well, even if it is necessary to admit that in the other sense it is not a true index.

The "ossification index" brings order and compactness to a subject which has

always been vague in the average medical mind. With the "index" the roentgenologist can send an understandable report to the referring clinician and if the latter, through greater than average familiarity with the irregularities of early ossification, wishes to go beyond the automatic interpretation suggested, the "index" can still be found to contain much of the information necessary for his more refined analysis. The individual clinician may reconstruct a mental picture of the roentgenogram from which the "index" was taken and draw his independent conclusions regarding the applicability of these data in the wrist to the entire body of his patient. The use of the "ossification index" is suggested for those who write or speak of delay or precocity³ of bone formation and wish a concise way of demonstrating the facts to the listener. That most of the disturbances of the ossification rate are due to endocrinopathy has been accepted, but the finding of delay graphically recorded in the "index" cannot by itself establish either the diagnosis of hypothyroid-

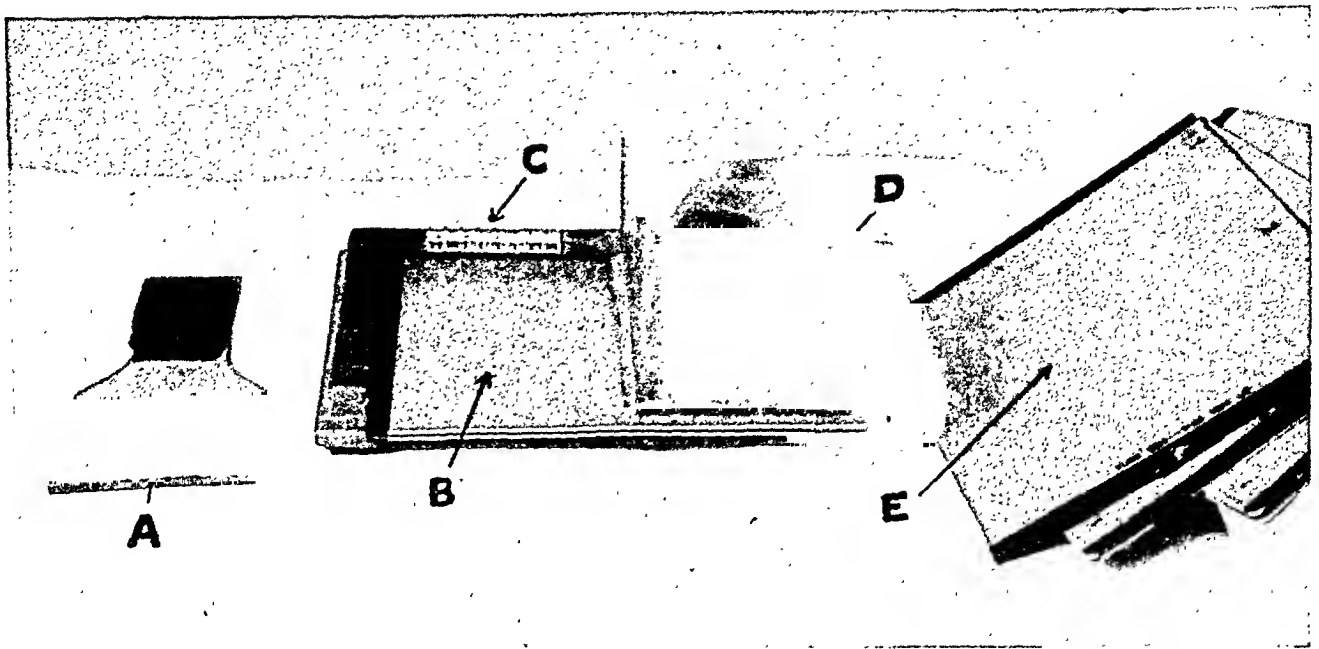


FIG. 4. Improved holder for films to make possible the rapid taking of wrist roentgenogram at any age. Felt padded board (A) is hooked under the upright portion of the holder and pushed down onto the hand to hold it against the cardboard film holder (B) when fixation is necessary. The unused half of the film is covered by a lead shield (D) and the numbers placed in an attached film marker (C) record the age and identity of the patient. Film holder is withdrawn from the slot and changed end-for-end to expose the unused half while a supply of loaded holders (E) is ready in some suitable place for additional patients.

ism,^{5,7} pituitary deficiency,^{1,2} rickets⁶ or dwarfism.^{1,7} As always in such studies, the entire clinical picture must be considered. It is also a fact that the finding of normal ossification cannot be taken as excluding the possibility of acute endocrine dysfunction which has been present too short a time to affect the process. And yet, it can still be repeated that the demonstration of abnormal delay in bone formation through the use of the "ossification index" with the age figures chosen is always significant and a hunt for corroborating and differential signs such as the changes in the radius described by Woolley⁸ should be instituted.

CONCLUSION

It is suggested that the general practitioner, the school doctor and the pediatrician employ the simple expedient of referring the subnormal child to the roentgenologist for roentgen-ray measurement offered by the "ossification index." This would be an easy initial step in the study of such a child.

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Acknowledgment is made to Miss Phyllis Fowler, roentgen technician, and to Mr. Peter McDonnell for technical assistance in the collection and tabulation of clinical material in this study.

REFERENCES

1. ENGELBACH, W., and SCHAEFER, R. L. Endocrine dwarfism. *J. A. M. A.*, 1934, 103, 464-468.
2. FINKLER, R. S., FURST, N. J., and KLEIN, M. Clinical roentgenological study of effects of hormonal therapy on bone growth. *Radiology*, 1944, 43, 346-357.
3. KENNEDY, R. L. J. Precocious skeletal development. *J. A. M. A.*, 1945, 127, 580-581.
4. LEONARD, D. W. Early recognition of endocrine disorders in childhood by roentgenograms of the wrist to determine the "ossification index." *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 53, 55-61.
5. SHELTON, E. K. Hypothyroidism in childhood. *J. A. M. A.*, 1941, 117, 1948-1950.
6. SCHWARZENBERG, L. J., VALLE, Q. E., and AGUILERA, A. Valor del test nuclear en el diagnóstico radiológico del raquitismo. *Rev. chilena de pediat.*, 1941, 12, 761-790. Abst in *J. A. M. A.*, 1942, 118, 1166.
7. WILKINS, L., and FLEISCHMANN, W. Diagnosis of hypothyroidism in childhood. *J. A. M. A.*, 1941, 116, 2459-2465.
8. WOOLLEY, P. V., JR., and McCAMMON, R. W. Bone growth in congenital myxedema. *J. Pediat.*, 1945, 27, 229-235.

THE ROENTGEN AND CARDIAC MANIFESTATIONS OF FUNNEL CHEST*

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FUNNEL chest, or pectus excavatum, has received scant attention in the literature and textbooks. The first clinical description is credited to Johann Bauhinus, who in the sixteenth century, described a case with "... dyspnea, associated with cough increasing to paroxysms of suffocation."⁸ Von Eggel, in 1870, described cases with cardiac embarrassment which he attributed to the deformity. A monograph of 21 case reports was published in 1904 by Gerstenberg. With the advent of roentgenography, the effect of this deformity upon the position and shape of the heart was noted by a number of observers (Verse, 1910; Stadtmuller, 1920; Sauerbruch, 1920; Meyer, 1911; von Hoffmeister, 1927; and Alexander, 1931).³

Figures 1 to 9 illustrate our 9 cases of funnel chest. The salient clinical, roentgeographic, and electrocardiographic features of each accompany the illustrations.

Funnel chest is not a rare condition. Since the greatest number of individuals having this deformity are without troublesome symptoms, only an occasional one will present a medical problem, and only a small number of these will be reported in the literature.

The malformation is a developmental anomaly in nearly all instances.⁸ The defect, however, may be hereditary, as noted in Cases III, IV, V, and VII, where it was present in one or more members of the patient's immediate family. In severe rickets this type of deformity may sometimes result, although pigeon chest is a far more

common finding. Obstruction to free respiration in children with forced respiratory movements has been considered as a possible etiology, but this seems unlikely. Severe trauma to the sternum may produce an angulated fracture with resultant funnel chest. This possibility is considered in one of our cases (Case VIII).

In the non-traumatic cases, there is usually no deformity present at birth. In the first years of life the sternal depression appears and gradually becomes increasingly more marked. Because it is absent at birth, the maldevelopment may be erroneously attributed to rickets, or obstructive respiration.

Funnel chest is due to a posterior position of the sternum with relation to the lower anterior chest wall. The manubrium is usually not involved, and the lower segment of the corpus sterni commonly forms the most posterior portion of the deformity.³ The anterior ribs and costal cartilages maintain their normal position, leaving the anterior chest wall intact on both sides of the sternum and allowing a depression to be formed centrally. The deformity may be of varying degrees, with a depth reaching at times to 7 or more centimeters in severe cases. Not uncommonly, the depression is somewhat irregular, with the greatest depth not centrally placed.

The heart, lying beneath the sternum, is directly affected by the deformity. A displacement of the heart to the left is a fairly constant finding and was noted by a number of early observers.^{3,8,20} Sometimes the

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FIG. 1, *A* and *B*. Case 1. F. W., clerk, aged eighteen. *Family history*: Not significant. *Past history*: "Growing pains" and acute tonsillitis as child. *Symptoms*: Palpitation on rest and exertion, dyspnea on exertion. Fair capacity for work. Faints easily. *Physical findings*: Blood pressure, 120/80; pulse at rest 80, after exertion 110, two minutes following exertion 96. Slight right upper quadrant abdominal tenderness. Maximum depression of the lower sternum 3.5 cm. *Electrocardiogram*: PR interval 0.20 sec., inverted T₃. *Roentgen findings*: Funnel chest deformity of the lower sternum with shift of the heart to the left.



FIG. 2, *A* and *B*. Case 11. W. M., economic analyst, aged thirty-two. *Family history*: Not significant. *Past history*: Scarlet fever followed by nephritis. *Symptoms*: Palpitation only when sleeping on the left side. Engages in strenuous exercise without ill effect. *Physical findings*: 1+ cyanosis of the nails, bigeminal rhythm. Blood pressure, 145/65. Maximum depression of the lower sternum 7 cm. Distance from the lowest point of depression to the ventral surface of the dorsal spine 6.5 cm. *Electrocardiogram*: See text for complete discussion. *Roentgen findings*: There is a marked concavity deformity of the anterior chest with the heart shifted to the left although it is not enlarged.



FIG. 3, *A* and *B*. Case III. W. F., clerk, aged seventeen. *Family history*: Father and brother have funnel chests. *Past history*: Not significant. *Symptoms*: "Shortwinded" with moderate exertion. *Physical findings*: Blood pressure 115/70; deformity extends almost entire length of the sternum and ends in a flaring of the lower costal margin. Maximum depression 3.5 cm. *Electrocardiogram*: Slight right axis deviation, notching of P2 and P3, inverted CF₄. *Roentgen findings*: Fairly marked funnel chest with displacement of the heart to the left.

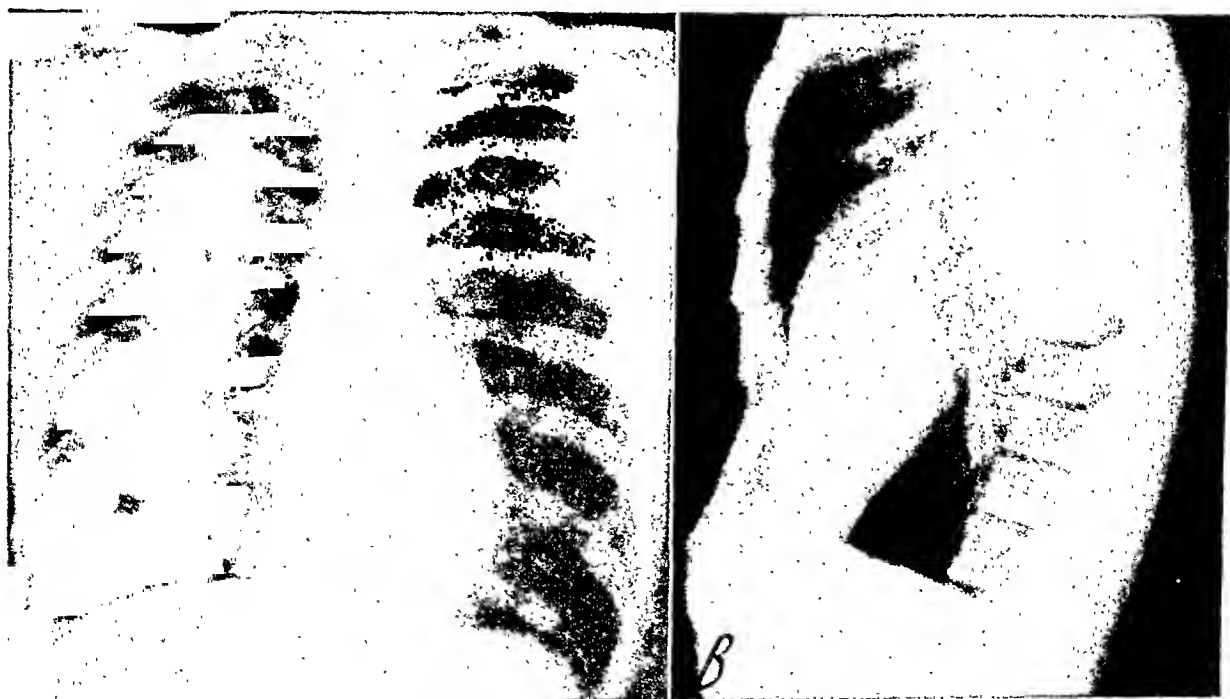


FIG. 4, *A* and *B*. Case IV. W. M., Maritime Service enrollee, aged twenty-two. *Family history*: Father has a slight funnel chest. *Past history*: Pneumonia, nephritis, tonsillitis. *Symptoms*: Palpitation with excitement and dyspnea with severe exertion, occasional episodes of "weakness" early in morning particularly in hot weather, mild chest pain when leaning to the left with the left arm outstretched; distress is localized in the left lower anterior chest and is definitely related to position changes—no anginal features. *Physical findings*: 1+ cyanosis of the nail beds. Blood pressure, 110/64, chest deformity is shallow and diffuse, measuring 9 × 11 × 3.5 cm. and extending upward to the level of the anterior third rib; left side of chest grossly more flattened than the right. *Electrocardiogram*: Not abnormal. *Roentgen findings*: Funnel chest deformity.



FIG. 5, *A* and *B*. Case v. W. F., social science analyst, aged thirty-one. *Family history*: Brother and daughter have funnel chests. *Past history*: Nephritis. *Symptoms*: Palpitation and dyspnea with moderate exertion, occasional ankle edema after standing for long periods. *Physical findings*: functional systolic murmur at the pulmonic area. Blood pressure, 110/70, maximum depression of the lower sternum 4 cm. *Electrocardiogram*: Inverted T in CF 4. *Roentgen findings*: Marked concavity deformity of the lower sternum. The heart is displaced to the left and shows a prominent pulmonary conus.

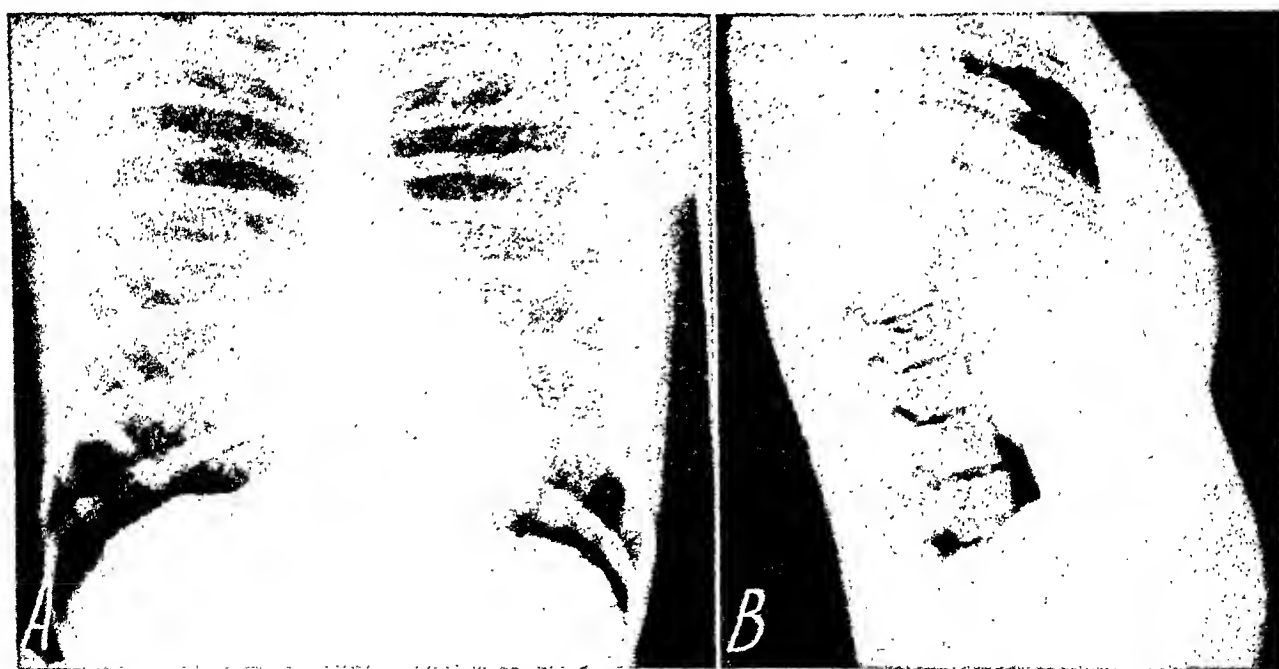


FIG. 6, *A* and *B*. Case vi. C. F., clerk, aged nineteen. *Family history*: Not significant. *Past history*: Influenza. *Symptoms*: Palpitation and dyspnea with moderate exertion, occasional attacks of dizziness with sudden changes in position. *Physical findings*: Blood pressure, 130/70, maximum depression of the lower sternum 3.5 cm. *Electrocardiogram*: Broad S wave in lead 2. *Roentgen findings*: There is a funnel chest deformity of the sternum with slight displacement of the heart to the left.



FIG. 7, *A* and *B*. Case VII. W. M., clerk, aged twenty-six. *Family history*: Brother has a funnel chest. *Past history*: Not significant. *Symptoms*: Intermittent pain in the left chest aggravated by coughing. *Physical findings*: Blood pressure, 110/65, slight hyperesthesia over the fourth and fifth anterior ribs in the mid-clavicular line, maximum depression of the lower sternum 4 cm. *Electrocardiogram*: Elevated ST segment in leads 1 and 2 (less than 1 mm.), slurred QRS in leads 2 and 3, low voltage T wave in lead CF 4. *Roentgen findings*: There is a funnel chest with slight displacement of the heart to the left. The heart is not enlarged.



FIG. 8, *A* and *B*. Case VIII. W. M., cost accountant, aged fifty-one. *Family history*: Not significant. *Past history*: Influenza, pleurisy, scarlet fever, nephritis. Does not recall the presence of the deformity prior to the time he was kicked in the chest by a horse at the age of ten years. *Symptoms*: Dyspnea and palpitation on exertion, occasional bouts of ankle edema after standing for long periods, occasional fleeting chest pains along both costal margins; no anginal features. *Physical findings*: 1+ cyanosis of the nail beds. Blood pressure, 135/95, epigastric pulsation with loud blowing epigastric systolic murmur, maximum depression of the lower sternum 4.5 cm., minor varicosities of the lower extremities. *Electrocardiogram*: Slight elevation of the ST segment in leads 2 and 3, small R and deep S wave in lead CF 4, notched P wave in lead 2. *Roentgen findings*: Funnel chest deformity of the sternum with slight shift of the heart to the left. There is no evidence of old rib fracture to substantiate a traumatic etiology of the deformity.

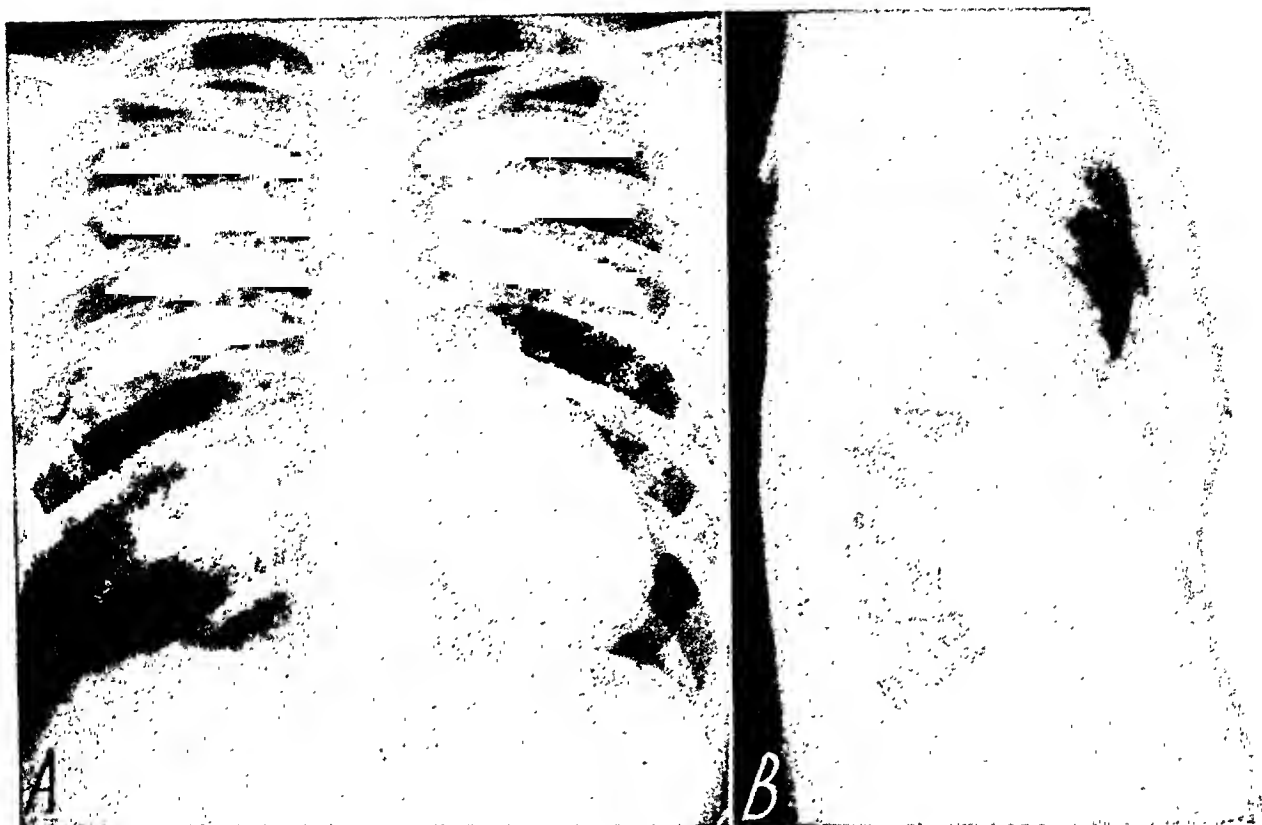


FIG. 9, *A* and *B*. Case 1x. W. F., stenographer, aged twenty-nine. *Family history*: Not significant for other cases of funnel chest. Believes that two brothers have "heart disease" but does not know the type. *Past history*: Influenza. *Symptoms*: Palpitation at rest and with exertion, dyspnea on moderate exertion, edema of the ankles in hot weather, occasional pain in region of the second left thoracic interspace when fatigued, dull and somewhat constricting in character. *Physical findings*: Blood pressure, 110/70, second pulmonic wound louder than the aortic second, maximum depression of the lower sternum 3.5 cm. *Electrocardiogram*: Slight right axis deviation, slurring of the R wave in leads 2 and 3, low voltage of the T wave in lead CF 4. *Roentgen findings*: There is a moderate funnel chest deformity with a corresponding shift of the cardiac silhouette to the left. The heart is not enlarged. There is a wedge-shaped tenth dorsal vertebra which is probably congenital in origin.

cardiac displacement may be only slight but occasionally the entire heart may be so shifted as to be found lying in the left chest. Cardiac rotation in the sagittal plane may be present (Stadtmuller) but the heart is rarely widened in its lateral diameter.³

The roentgen findings are quite characteristic. In the posteroanterior view, the heart is shifted to the left, with some elevation of the left border from the diaphragm. This appearance is readily mistaken for a right ventricular enlargement, and since the right cardiac border is usually hidden by a vertebral column, an interpretation of cardiac enlargement could be made unless the true situation is realized (Fig. 1, 2, 3, 5, 6, 7, 8 and 9). One of our patients (Case III) had been told a number of years ago that her heart was enlarged, and that she

should adopt a conservative exercise program.

On lateral view, the diagnosis is self evident. The sternum protrudes backward, and is well behind the anterior chest wall (Fig. 1-9).

In examining photofluorograms of the chest it is important to be aware of the cardiac picture in funnel chest. Oftentimes, on the single posteroanterior roentgenogram, an erroneous interpretation of cardiac enlargement, congenital heart disease, or even mitral disease may be made. Even without a significant history or lateral roentgenogram, a presumptive diagnosis of funnel chest can be made when the heart is displaced to the left, with the right cardiac border hidden by the vertebral column, and with an elevated rounded left

lower cardiac border. This, of course, presupposes the absence of visible lesions which commonly cause a left cardiac shift, such as scoliosis, left pleural thickening, left-sided atelectasis, right-sided pleural fluid, tumors and other known conditions.

Of our 9 cases, all but 1 (Case IV) had a well marked displacement of the heart to

ring in association with funnel chest. In Grieshaber's series right axis deviation occurred in 50 per cent (mild in 17 per cent, marked in 33 per cent). This finding was noted particularly with funnel chest of moderate and advanced degree with the heart lying to the left. Left axis deviation occurred in only 20 per cent of his series.

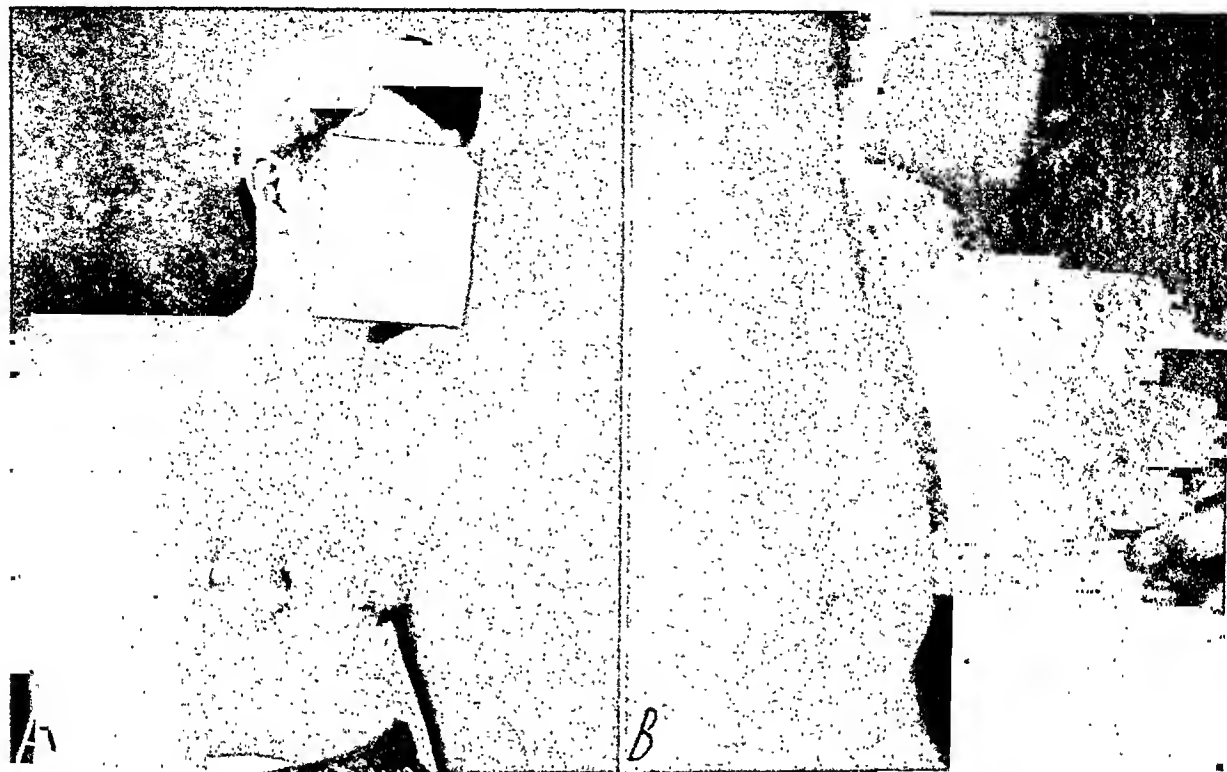


FIG. 10, *A* and *B*. Front and side view of Case II showing the marked depth (7 cm.) of the lower sternal depression. See Figures 2, 11, 12, 13, and the text for complete clinical discussion including roentgen and electrocardiographic findings.

the left. In this case, there was some pleural thickening in the right costophrenic angle which may have pulled the heart somewhat from its expected left-sided position. This is, of course, purely speculation.

Another striking feature in a number of cases is the prominence of the right hilar and trunk shadows which are normally obscured by the overlying right cardiac border. This finding may at times be misinterpreted as an abnormal density in the right hilum and base resulting in an erroneous impression of pneumonitis or congestion.

The literature offers several instances of electrocardiographic abnormalities occur-

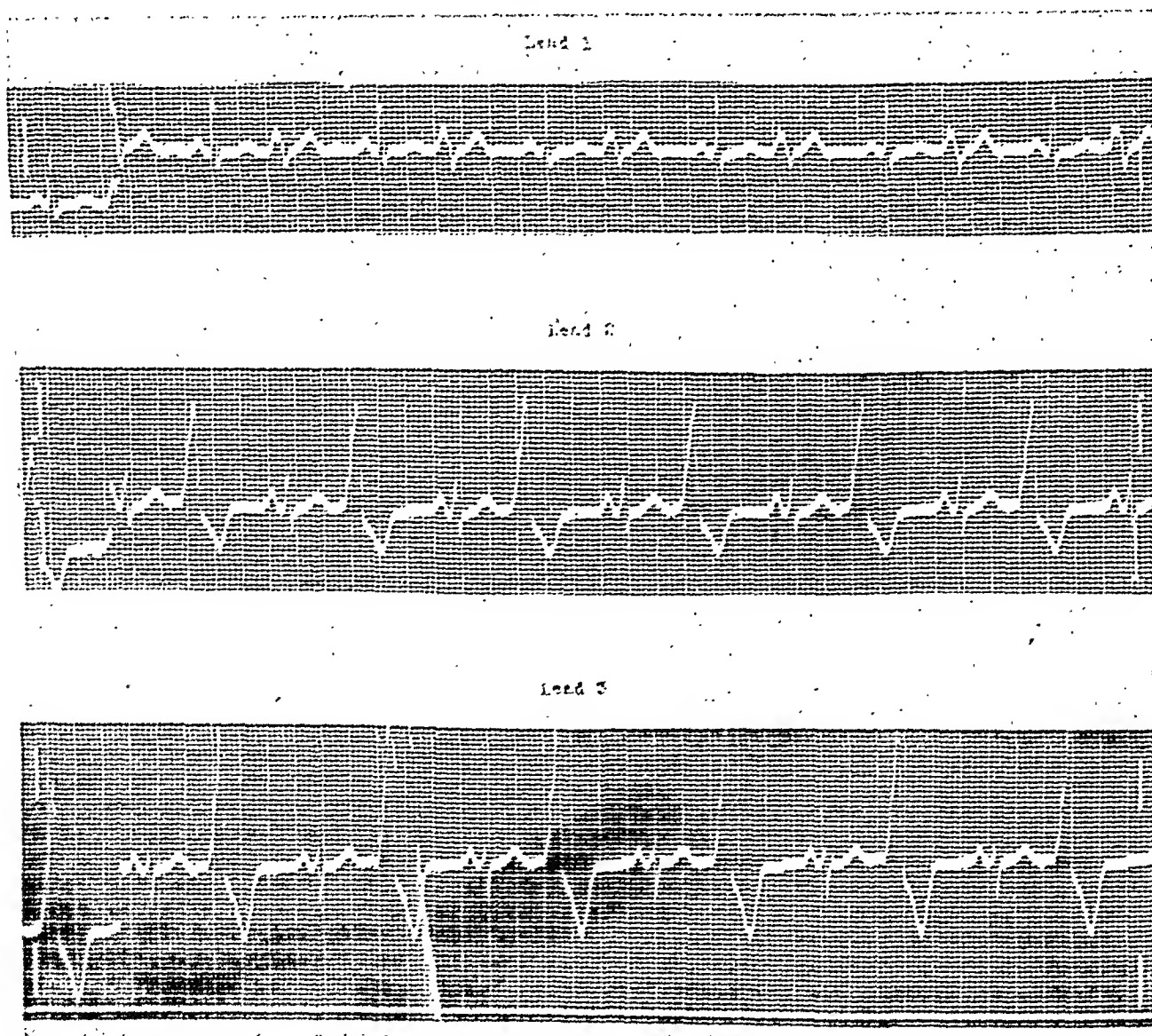
P wave changes were encountered quite commonly and usually consisted of an enlargement of this complex most commonly in lead 2, and often associated with changes in the ST segment and T wave.⁷ The PR interval was usually found to be unchanged. All varieties of T wave change including voltage elevation, peaking, particularly in lead 2 and less often in leads 1 and 3, and diphasic and negative complexes in leads 2 and 3 have been reported.^{3,7,8} ST elevation was reported often by Grieshaber⁷ but was of minimal degree and "... does not compare with that found in pericarditis and myocardial infarction." That author points out the necessity of recognizing

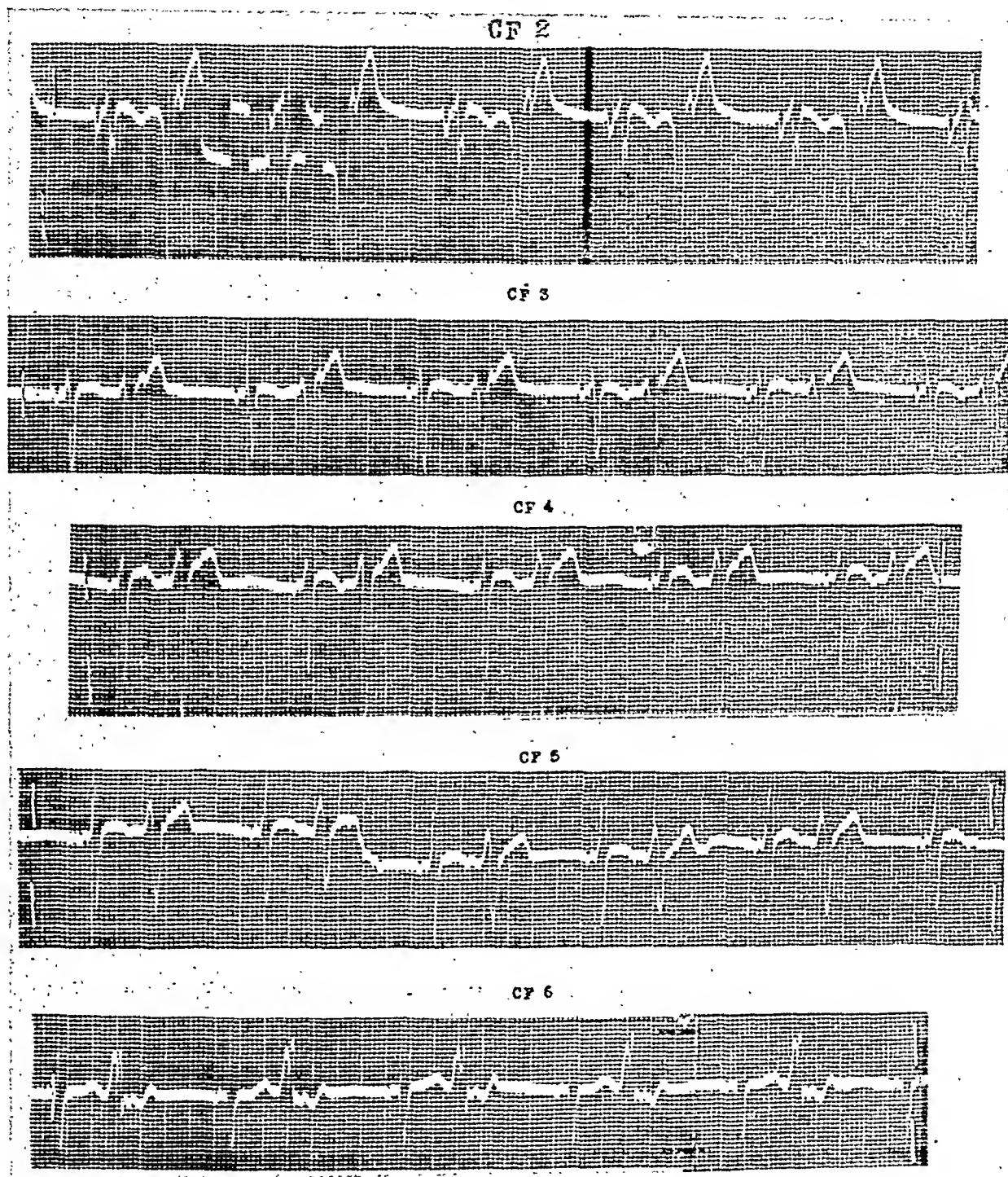
changes due to respiratory and extracardiac neurogenic influences. Alterations in his tracings taken after exercise were not remarkable and in only two instances did the T wave in lead 1 become smaller with a simultaneously unchanged T wave in leads 2 and 3, a pattern which he states is, "... more frequent with heart injury than with a sound condition."

The electrocardiographic changes in our series were of a relatively minor nature, as would be expected since none of the patients had any known cardiac pathology. Right axis deviation occurred twice (Cases III and IX) out of a total of 9 cases and in each instance was of a relatively slight degree. P wave changes were also less frequent than in Grieshaber's series, notching

in leads 2 and 3 occurring in 1 case (Case III). No cases of large P waves previously described⁷ were encountered. Minor ST segment elevations were found in 2 leads in each of 3 cases (Cases IV, VII and VIII) but in no case did the elevation exceed 1 mm. Notching and slurring of QRS was common especially in connection with S waves in the standard leads. A definite S wave occurred 5 times (Cases I, III, IV, VI and IX) and was deep in 2 instances (Cases III and IX). This finding was mentioned by Grieshaber as being an accompaniment of the cardiac rotation which commonly occurs in funnel chest.

To our knowledge, the electrocardiographic changes occurring in the chest leads in association with this condition





B

FIG. 11, *A* and *B*. Control tracing of Case 11 showing the standard (*A*) and CF chest leads (*B*). There is a bigeminal rhythm with regularly occurring right ventricular extrasystoles. Rate 100, PR interval .14 sec. in the sinus beats. QRS interval .07 sec. for the sinus and .12 sec. for the ectopic beats. Axis deviation, approximately 25 degrees. Principal initial deflection of the extrasystoles is upright in all leads. T waves of the sinus beats are inverted in leads CF₂, CF₃, and CF₄. T waves of the ectopic beats are opposite to the principal deflection of QRS except in lead 1, where the small total deflection of QRS suggests that this may be an "unfavorable" lead.

have not previously been described. Lead CF₄ was taken on each patient. In 2 instances (Cases II and VII) the ST segment was slightly elevated while QRS was

notched or slurred in approximately half of the series (Cases II, III, VI and VIII). Four times the principal deflection of the QRS complex was directed downward

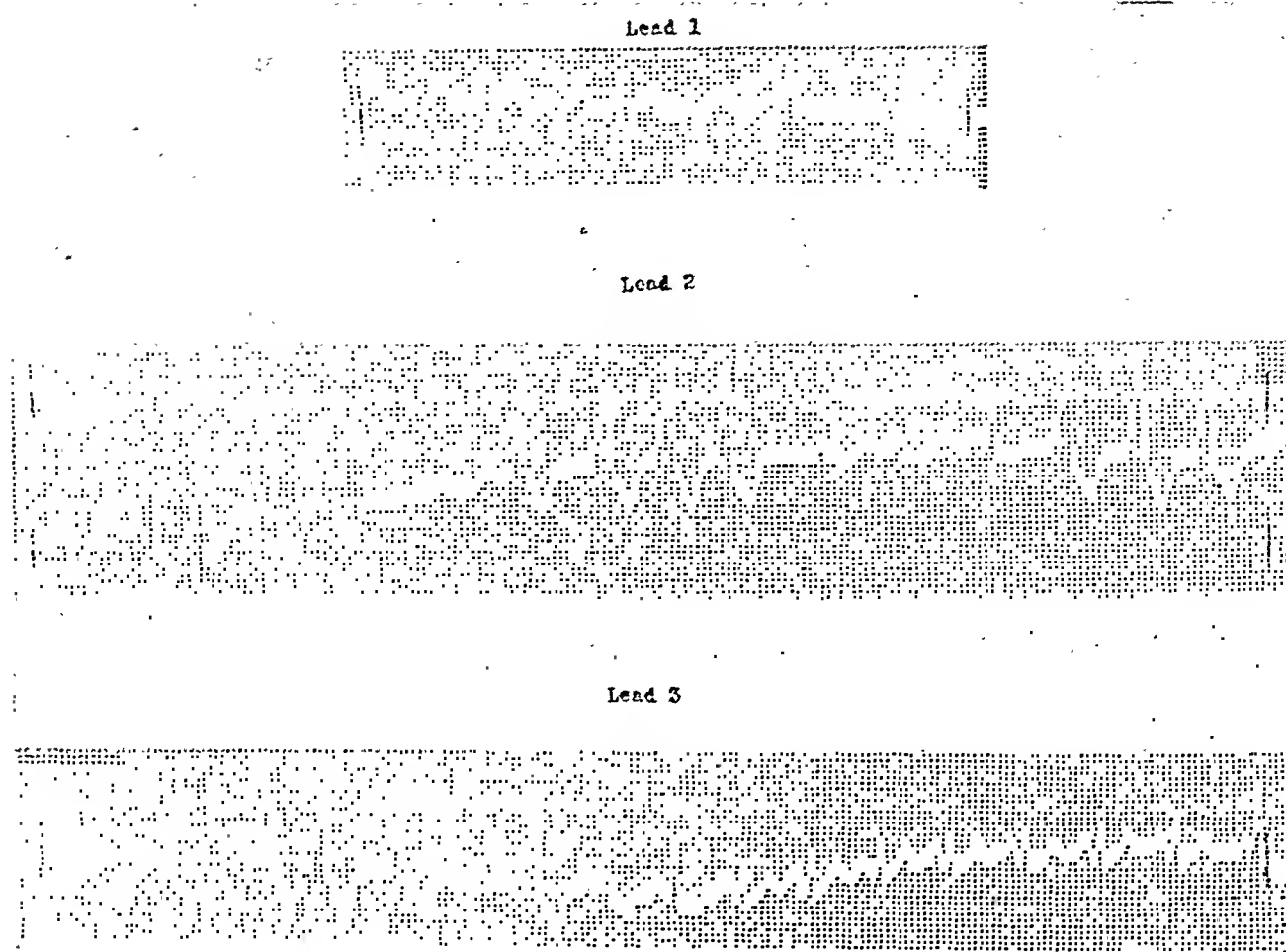


FIG. 12. Tracing taken directly after exercise. The rate of the paroxysms of tachycardia range from 130–188, averaging 146. The rate of the sinus rhythm varies from 120–146, averaging 128. Note the P waves notching the downward limb of the T complex in the ectopic beats in leads 2 and 3 as well as the extremely short PR interval (.07 sec.) in the transition beat occurring in the center of lead 3.

(Cases IV, V, VIII and IX). T Wave changes were common, the complex being diphasic 3 times (Cases II, III and IV), low voltage twice (Cases VII and IX) and inverted twice (Cases V and VIII).*

In summary we may say that minor variations in the electrocardiogram are common in this condition and are probably due to a change in position of the heart attributable to the deformity rather than to myocardial pathology. T wave changes in lead CF_4 were found to be the most constant variation in our series.

One rather interesting case of arrhythmia occurred which was considered worthy of more detailed study (Case II; Fig. 10). This consisted of a bigeminal rhythm which was easily detected by clinical examination. The patient had been told previ-

ously that something was wrong with his heart although he had not noted any subjective manifestations, and he was under the impression that he had been placed in 4F draft classification because of a "bad heart." Electrocardiographic tracings taken at rest showed alternating ventricular extrasystoles which had a chief initial deflection directed upward in all leads suggesting a focus of origin in the right ventricle near the conus¹⁵ (Fig. 11 and 14). In this connection it is interesting to point out that von Pohl, Henschen, and Nageli mentioned postmortem findings in cases of funnel chest consisting of grooving of the right ventricle but these evidently were not accompanied by cardiac arrhythmia.⁸ The only previous case of disturbed rhythm occurring in association with funnel chest was a patient with paroxysmal auricular fibrillation.^{3,8}

* The majority of our patients were young adults.

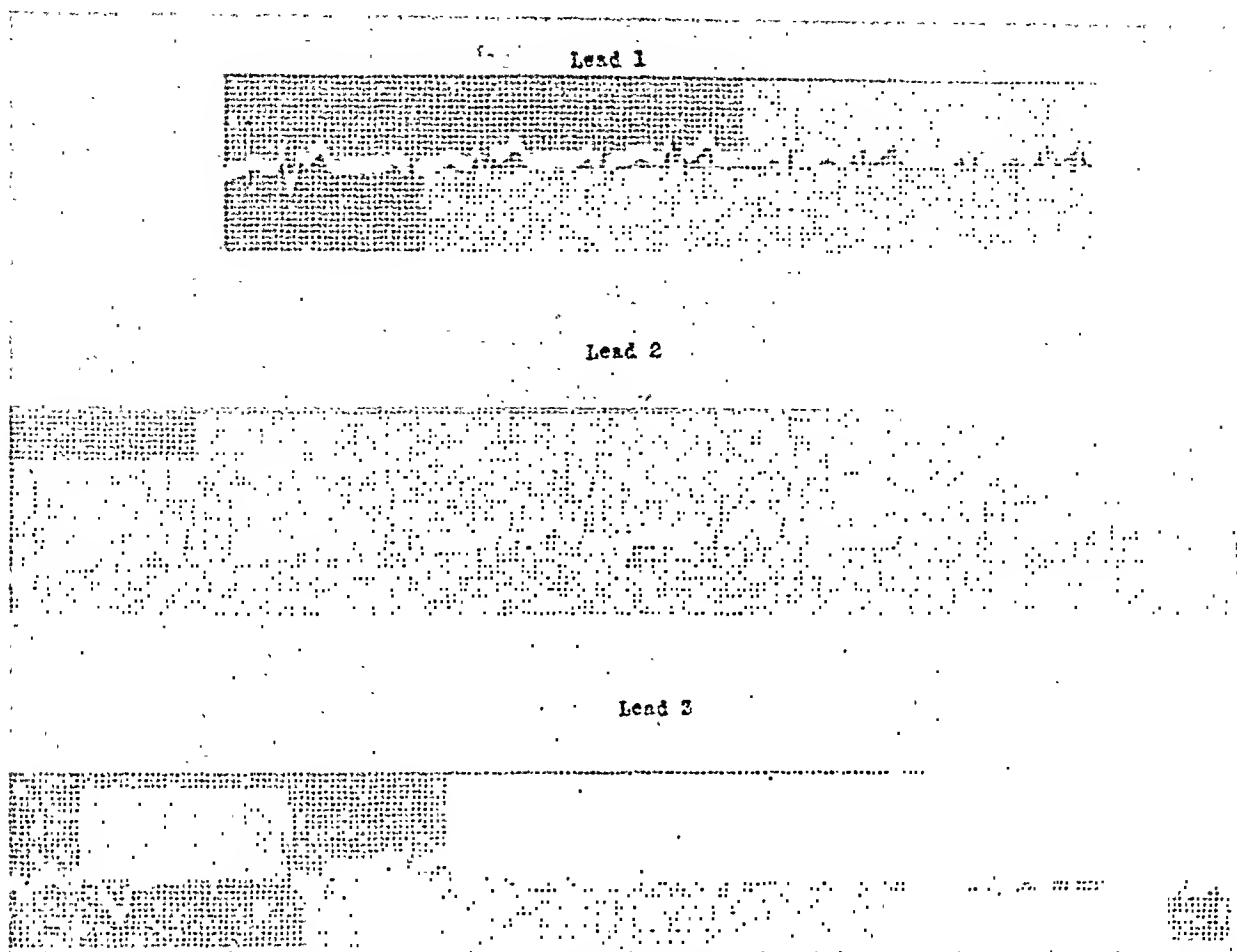


FIG. 13. Tracing taken three minutes after exercise. There has been a complete return to bigeminal rhythm and the form closely resembles that of the control record.

Needless to say, we were well aware of the fact that displacement of the heart will have an effect on the normal electrocardiographic complexes and probably also on the recorded form of premature beats. The concept of the localization of the origin of ventricular extrasystoles as it exists today is based primarily on observation and experimentation involving human and animal hearts. The human observations have the disadvantage of being, in most instances, studies on single cases of diseased hearts,^{1,11,12,23} while the animal experiments have the drawback of involving different thoracovisceral relationships which are present in the lower mammalian forms used, for the most part dogs, where there is a difference in the anatomical relation of the ventricles to each other and in the relation of the heart to the chest wall.¹⁵ Most authors agree, however, that to give a

chief initial deflection upward in all three leads the stimulus must originate in the right ventricle, near the base, in the region of the pulmonary conus^{1,2,4,12,13,15,17,19,21,22,23,24} (Fig. 14). Examinations of the chest roentgenograms of this case show that the above mentioned area is the likely site of bony pressure resulting from the deformity.

Figure 12 shows the effect of exercise (jumping up and down until marked dyspnea was produced) on the rhythm. This tracing shows runs of ventricular paroxysmal tachycardia alternating with periods of normal rhythm. It should be noted that the transition phases in leads 2 and 3 exhibit ectopic beats which differ in form from the other extrasystoles. These represent instances in which the normal and ectopic impulses both enter different parts of the ventricles so nearly at the same time that contraction begins in two places at

once. The resultant beats exhibit a ventricular complex which seems to be a composite of the usual premature beat and of the complex of the normal beat. The runs of extrasystoles occurring after exercise demonstrate a heightened irritability of the ectopic focus which vies with the sinoauricular pacemaker for domination.

The tracing (Fig. 13) was taken three minutes after exercise and represents a

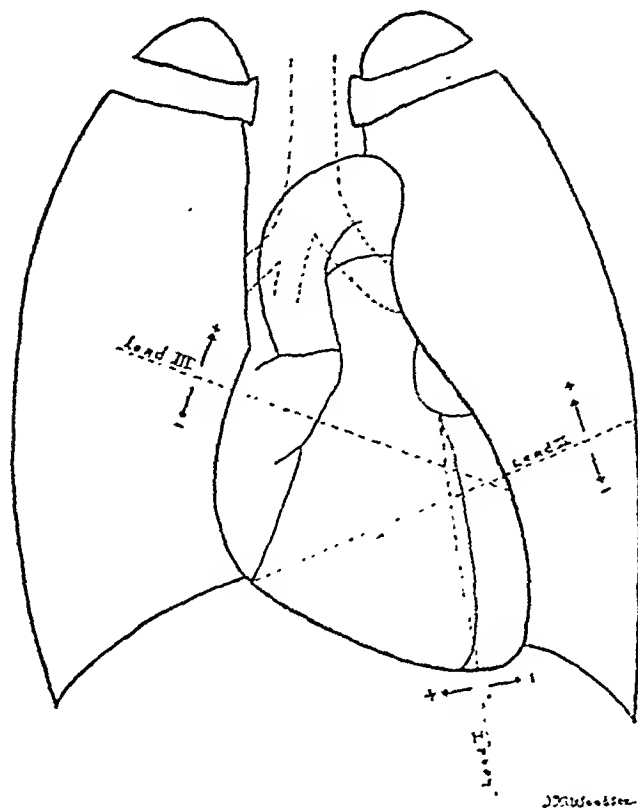


FIG. 14. Diagram of the ventral surface of the heart and great vessels. The dotted lines represent the theoretical planes of demarcation which may aid in predicting the area of origin of an ectopic stimulus from the pattern of the chief initial deflection of the premature beats in the standard leads of the electrocardiogram. It is likely that similar areas may be outlined on the posterior surface of the heart.

complete return to bigeminal rhythm. This reversion was so rapid that it was necessary to exercise the patient between each lead since facilities were not available for taking them simultaneously.

Tracings following the injection of 1/75 grain of atropine showed no change in the character of the bigeminal rhythm.

In the literature funnel chest has been credited with producing various cardiac

manifestations such as dyspnea, cough, paroxysms of suffocation,²⁰ and rapid heart action.⁸ Sauerbruch has stated, "... a high grade disturbance of cardiac and pulmonary function may occur with signs of congestion of the peripheral vessels."² Recent investigations have tended to question the frequency of these manifestations, however, and we are in agreement with Ediken, Wolforth, and others⁸ in the belief that uncomplicated non-traumatic developmental funnel chest usually does not produce symptoms of a serious nature, probably due to the adequacy of the various compensatory mechanisms which have been described.^{3,8} When questioned directly, several of our patients said that they had noted dyspnea on exertion and palpitation with exertion or excitement. These complaints were not marked, however, and caused no serious handicap. In this connection Grödel has pointed out that the deformity is often associated with an asthenic habitus which in itself may be associated with dyspnea and fatigue.⁸ Moreover, the unusual contact of the heart with the chest wall found in this condition may in itself be productive of a greater or lesser degree of heart consciousness. Chest pain occurred in 4 cases (Cases IV, VII, VIII and IX) but was not characteristic of the type usually associated with organic heart disease. Two patients (Cases VIII and IX) complained of occasional ankle edema but had no other signs or symptoms of cardiac failure. Minor varicosities of the lower limbs were present in one of these (Case VIII). Significant cardiac physical findings were encountered in only one case (Case II). Diastolic clicks and friction rubs previously reported²⁰ were not found. Blood pressure readings were within normal limits with the exception of a slight systolic elevation in one patient (Case II). In one case (Case VIII) a prominent epigastric pulsation and systolic blow over the abdominal aorta brought up the question of abdominal aneurysm. Slight cyanosis of the nail beds was observed 3 times (Cases III, IV and VIII) but was not considered to be of any

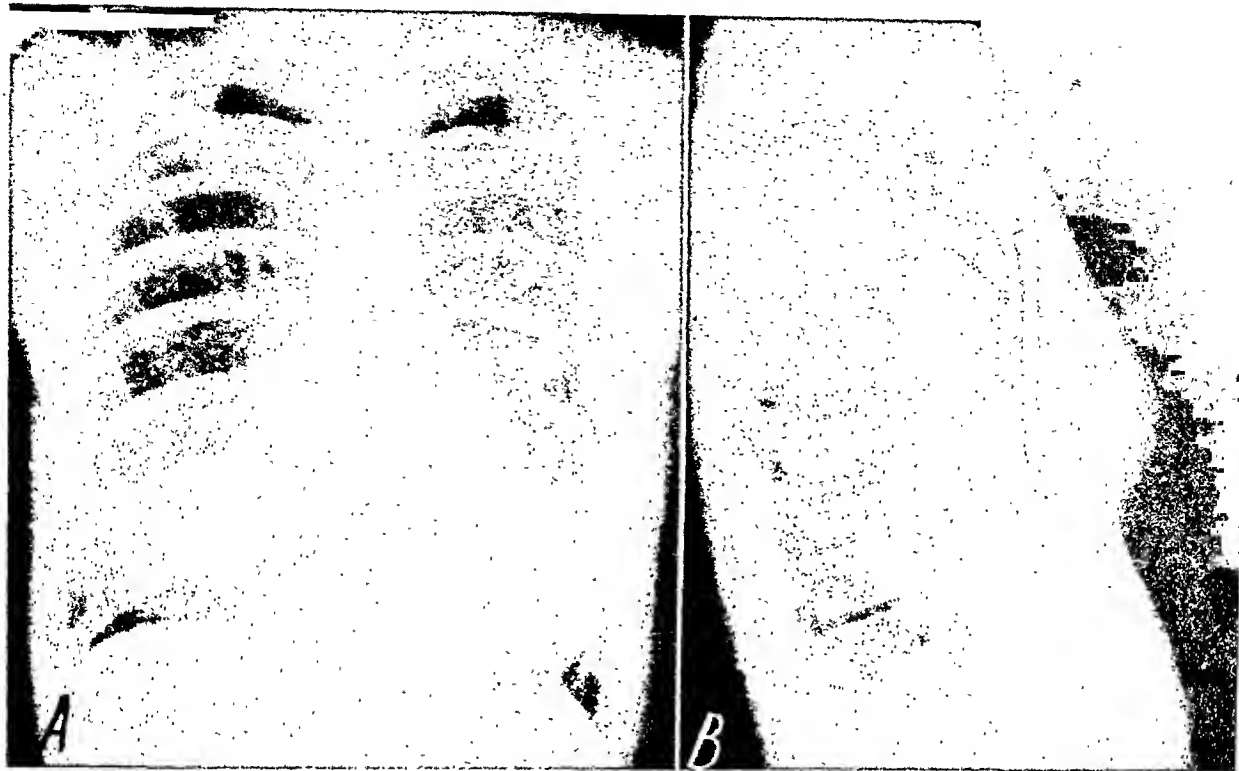


FIG. 15, *A* and *B*. W. F., clerk typist, aged twenty-seven. *Family history*: Not significant. *Past history*: Scarlet fever, migraine, "growing pains" as child, left upper tuberculosis discovered in 1940; pneumothorax initiated at that time and carried to date; has worked full time since 1941. *Symptoms*: Palpitation noted four to five days before each refill when lying on the left side, dyspnea with exertion, occasional nocturia. *Physical findings*: Second pulmonic sound accentuated, grade 2 systolic murmur over the pulmonic area; varies with respiration. Blood pressure, 110/60, distant breath sounds on the left, maximum depression of the lower sternum 3.5 cm. *Electrocardiogram*: Right axis deviation, plus 100 degrees. *Roentgen findings*: There is a pneumothorax with approximately 40 per cent collapse of the left upper lobe. Portions of the left upper lobe are held against the chest wall due to adhesions. The right lung field is clear. The heart is somewhat over to the left side. The lateral roentgenogram shows a moderate funnel chest deformity involving the lower sternum which accounts for the shift of the heart to the left.

significance. Mild hyperesthesia over the fourth and fifth ribs in the left mid-clavicular line was found once (Case VII). No patient exhibited cardiac enlargement although in all but one instance (Case IV) the heart showed the characteristic displacement to the left. Four patients gave a history of the deformity occurring, in a greater or lesser degree, in one or more other members of the family (Cases III, IV, V and VII). The patient in whom bigeminal rhythm was found (Case II) had been classified as unfit for military service because of the deformity and arrhythmia although he suffered no functional limitations and regularly engaged in strenuous exercise without ill effect. Another (Case VII) had been discharged from the Army, after three years of military service includ-

ing considerable combat, because of poor eyesight.

As shown by previous authors concurring on this subject,^{3,5} we found the deformity occurring most often in the lower portion of the sternum. In our series the depth of the depression varied from 3.5 to 7 cm. In the latter case (Case II) the distance from the maximum depression of the sternum to the ventral surface of the spine was 6.5 cm. Verse has recorded a case where this measurement was reduced to 1 cm.³

Most cases of developmental funnel chest necessitate no treatment. Surgical elevation of the sternum, however, may have to be considered, particularly in the traumatic group, when progressive cardiac manifestations are present that cannot be attributed to other causes. The case of Sauerbruch



FIG. 16, A and B. W. F., clerk, aged twenty. *Family history:* Brother has a funnel chest. *Past history:* Scarlet fever, tonsillitis, "kidney trouble." *Symptoms:* Palpitation and dyspnea with exertion, rare fainting spells, occasional fleeting attacks of chest pain located under the upper sternum, relieved by holding breath. *Physical findings:* P₂ greater than A₂, slurring of M₁. Blood pressure, 110/70, maximum depression of the lower sternum 3.5 cm. *Electrocardiogram:* Within normal limits. *Roentgen findings:* There is a moderate funnel chest deformity with shift of the heart into the left chest.

and von Hoffmeister which exhibited paroxysmal auricular fibrillation was relieved by operation.⁸ Complaints of a neurocirculatory nature, when present in these patients, are usually not directly attributable to the thoracic deformity and are best treated by a conservative program of graduated exercise. Reassurance may be very important in those cases where the malformation is a cause for excessive concern on the part of the patient.

SUMMARY

1. Nine cases of funnel chest are described, including one very unusual patient with bigeminal rhythm due to regularly recurring right ventricular extrasystoles. This is probably due to an irritable focus in the right ventricle resulting from the constant pressure of the deformed sternum in this region.

2. A characteristic roentgen finding in these cases is displacement of the heart to

the left associated with a characteristic appearance of the left cardiac border which can readily be mistaken for an enlarged heart, or a congenital or mitral heart.

3. Although several of the patients noted palpitation and dyspnea, especially after exercise, none of them had any serious cardiac embarrassment. Only one patient had important objective findings.

4. Minor electrocardiographic abnormalities are sometimes present, particularly in the chest leads. These are due to a combination of a shift to the left and a rotation of the heart on its long axis rather than to associated myocardial pathology.

5. Funnel chest is probably quite common. The interpreter of miniature chest films should be aware of the roentgen changes on the posteroanterior roentgenogram to avoid pitfalls in diagnosis.

6. Surgical treatment is rarely indicated. It should not be advocated unless there are clear cut findings of increasing cardiac em-

barrassment not attributable to other conditions.

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REFERENCES

1. BARKER, P. S., MACLEOD, A. G., and ALEXANDER, J. Excitatory process observed in the exposed human heart. *Am. Heart J.*, 1930, 5, 720-742.
2. BAUMANN, H., and WEBER, A. Klinische und experimentelle Studien über das Elektrokardiogramm; Bestimmung des Entstehungsortes von Kammerextrasystolen. *Ztschr. f. klin. Med.*, 1935, 128, 18-26.
3. CARR, J. G. Cardiac complications of Trichterbrust. *Ann. Int. Med.*, 1933, 6, 885-894.
4. CASTEX, M. R., BATTRO, A., and GONZALEZ SEGURA, R. Diagnosis of site of origin of ventricular extrasystoles in human beings. *Arch. Int. Med.*, 1941, 67, 76-90.
5. COOGAN, T. J. Analysis of an unusual case of coupled ventricular beats. *Med. Clin. North America*, 1934, 17, 1569-1573.
6. GARNIER, C. Traitement chirurgical du thorax en entonnoir. *Rev. d'orthop.*, 1934, 21, 385-433.
7. GRIESHABER, H. Das Herz bei Trichterbrust. *Helvet. med. acta*, 1937, 4, 462-487.
8. HUTCHESON, J. M. Cardiac complication of funnel breast. *South. Med. & Surg.*, 1939, 101, 266.
9. HUTTMANN, A. Ein bemerkenswerter Fall von ventrikulärer Bigeminie. *Wien. Arch. f. inn. Med.*, 1940, 33, 375-380.
10. KATZ, L. N., and ACKERMAN, W. Effects of heart's position on electrocardiographic appearance of ventricular extrasystoles. *J. Clin. Investigation*, 1932, 11, 1121-1239.
11. LUNDY, C. J., and BACON, C. M. Premature left ventricular beats from electrical stimulation of exposed human heart. *Arch. Int. Med.*, 1933, 52, 30-32.
12. MARVIN, H. M., and OUGHTERSON, A. W. Form of premature beats resulting from direct stimulation of human ventricles. *Am. Heart J.*, 1932, 7, 471-476.
13. MOIA, B., and BATLLE, F. F. El reconocimiento del origen de las extrasístoles ventriculares mediante la electrocardiografía. *Rev. argent. de cardiología*, 1937, 4, 271-277.
14. NAHUM, L. H., HOFF, H. E., and KAUFMAN, W. Configuration of anterior and posterior septal extrasystoles in standard leads of electrocardiogram. *Am. J. Physiol.*, 1941, 134, 398-402.
15. PARDEE, H. E. B. Clinical Aspects of the Electrocardiogram Including the Cardiac Arrhythmias. Paul B. Hoeber, Inc., New York, 1941.
16. PRINZMETAL, M., OPPENHEIMER, B. S., and DACK, S. Localization of ventricular extrasystoles in human heart with right axis deviation. *J. Am. M. Ass.*, 1937, 108, 620-622.
17. ROBB, J. S., ROBB, R. C., and HISS, J. G. F. Localization of premature beats in mammalian ventricle. *Proc. Exper. Biol. & Med.*, 1935, 32, 1510-1511.
18. SCHERF, D. Experimental study of reciprocating rhythm. *Arch. Int. Med.*, 1941, 67, 372-382.
19. SISTO, P. Studi sull'elettrocardiogramme seguente l'extrasistole ventricolare. *Minerva med.*, 1935, 2, 689-695.
20. SMITH, K. S. Heart in thoracic deformity. *Mid-dlesex Hosp. J.*, 1930, 30, 43-48.
21. UNGHVAR, L. Die Bestimmung der Ausgangsstellen der ventrikulären Extrasystolen. *Klin. Wchenschr.*, 1938, 17, 1115-1117.
22. VAN BOGAERT, A. Contribution à l'étude de la valeur localisatrice de la forme de l'extrasystole ventriculaire. *Arch. d. mal. du coeur*, 1937, 30, 461-466.
23. VANDER VEER, J. B. Premature beats produced by mechanical stimulation of exposed human heart. *Am. Heart J.*, 1933, 8, 807-809.
24. WEINSTEIN, J., and ABRAMSON, D. I. Localization of site of experimental premature contractions and bundle branch lesions by means of multiplane chest leads. *Ann. Int. Med.*, 1936, 9, 1187-1195.

ADDENDUM

Since this paper was completed two additional cases of funnel chest have come to our attention (Fig. 15 and 16). One of these (Fig. 15) is especially interesting since there was a left-sided therapeutic pneumothorax present with approximately 40 per cent collapse of the left lung. Despite this fact, the heart showed the characteristic shift to the left.



THE TECHNIQUE OF THE ROENTGENOLOGIC DEMONSTRATION OF PULMONARY INFARCTS*

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CONTRARY to the experience of some others elsewhere in this country, at the Massachusetts General Hospital pulmonary infarction has been one of the two most common postoperative complications. It is also one of the frequent medical problems which the internist asks the roentgenologist to study. Since a pulmonary infarct may be the first sign of impending massive fatal embolism, and since today certain preventive measures against fatal embolism are available,^{1,2} early recognition of infarcts becomes increasingly important. Valuable technical factors that have been evolved in recent years are of aid in the

roentgenologic demonstration of a pulmonary infarct as it becomes apparent. These points merit emphasis since all roentgenologists, those in private practice seeing ambulatory patients as well as those in the hospital encountering ill, bedridden ones, will be called upon at some time to recognize and diagnose pulmonary infarction.

Hampton and Castleman³ have furnished excellent descriptions, both roentgenologic and pathologic, of pulmonary infarcts in their various stages. Inasmuch as the appearances they depict are revolutionary when compared with former conceptions, the roentgen characteristics will be briefly

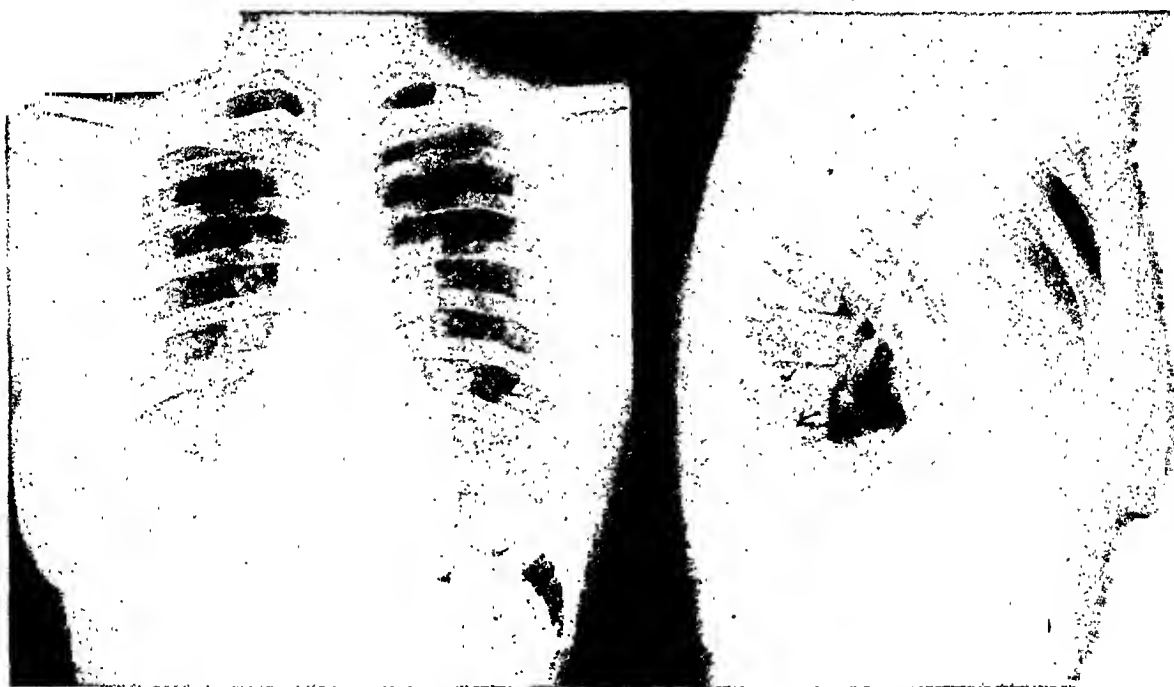


FIG. 1. R.S. (U-425299) Seventeen days after operation for a slipping patella, a nineteen year old girl developed severe pain in the right lower chest and top of right shoulder. The pain was not associated with a chronic cough of long duration. The leg had been in a cast constantly from the time of operation. She was readmitted to the hospital twenty-four hours after the onset of the chest pain. *Roentgen examination:* The anteroposterior view did not demonstrate the lesion. In the lateral view, the shadow seen with the curved anterior margin lying in the posterior right costophrenic angle was thought to represent an infarct.

Bilateral femoral vein ligation was done, and a large thrombus was removed from the right superficial and common femoral veins. Follow-up roentgenograms showed the characteristic appearance of healing infarct.

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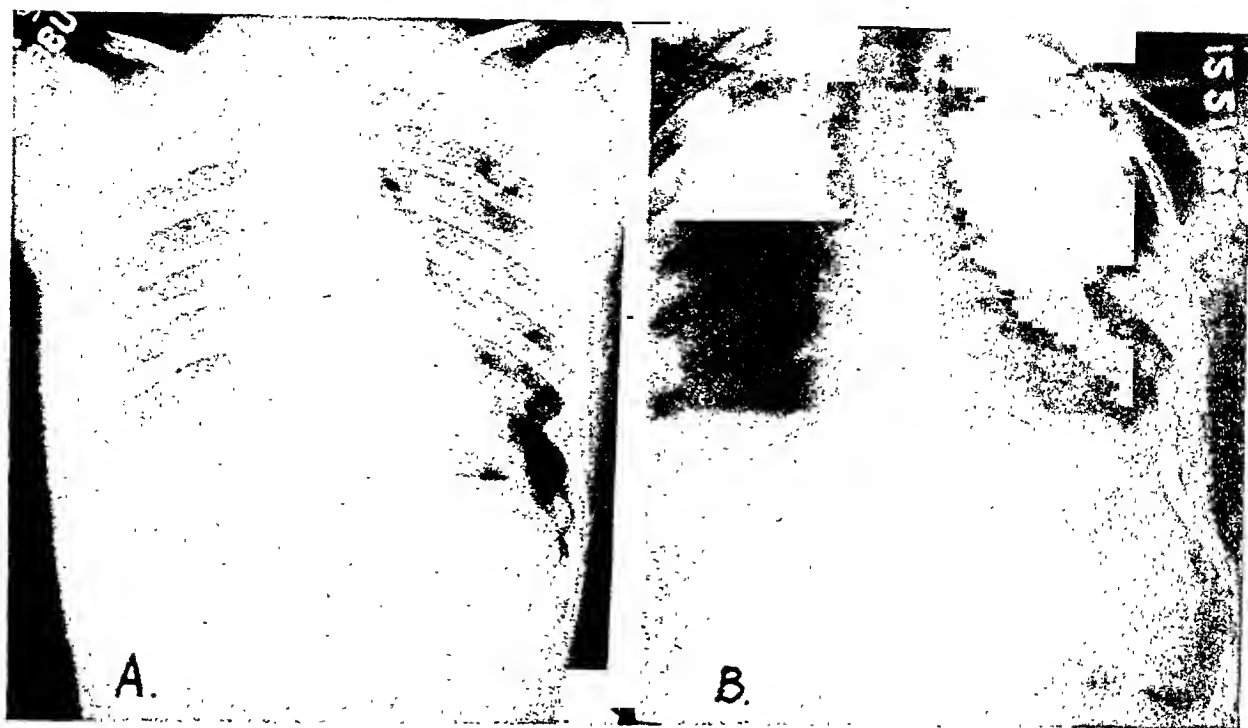


FIG. 2. J.F. (U-385476) A seven year old girl entered the hospital because of marked respiratory difficulty. There was a large fluctuant, reddish-blue swelling over the glabella with edema sufficiently marked to cause the eyelids to be closed. The abscess had developed gradually over a period of ten days. *Roentgen examination:* (A) Note pneumothorax on the left and a few mottled areas of increased density scattered through the right lung field. There is also a small amount of fluid in the right pleural cavity. (B) Roentgenogram taken ten days later shows a well defined abscess in the left lower lung field and two in the right lower lung field. Numerous blood cultures were positive for hemolytic *Staphylococcus aureus*. The abscesses healed rapidly, leaving minimal scars.

reviewed. The size of an infarct may vary from a small, thin lesion lying against the pleura to a large lesion occupying the greater portion of a lobe (Fig. 1). The shape of an infarct is dependent upon its location, but one characteristic is constant,—that is, an infarct is always peripheral, with its long dimension lying parallel to the pleura. As a rule its shadow has a curved proximal margin, the convexity being directed toward the pulmonary arterial source of the embolus. An infarct is at first indistinct and gradually it becomes more sharply circumscribed. In a period of time varying from days to months, it assumes a linear shape, and finally it may disappear except for a very thin linear scar.

Approximately 75 per cent of infarcts occur in the lower portions of the lungs, but it must be remembered that they may be found also in the upper lobes. The presence of a shadow in an upper lobe showing the

characteristics of an infarct should suggest this diagnosis.

Septic infarcts usually appear as areas of increased density with indistinct margins which gradually become round and sharply defined, and many of them develop a cavity within the center due to bronchial drainage. This type of infarct is a common complication of infections about the face and throat, of osteomyelitis, and of staphylococcal or streptococcal bacteriemia (Fig. 2).

TECHNIQUE OF EXAMINATION

If infarcts are to be suspected and differentiated from other processes within the lung, certain technical procedures must be followed in the roentgenologic examination. Unless the patient's condition forbids, a chest examination should always include roentgenoscopy. The possibility of diagnosing an infarct is of course dependent on securing for study roentgenograms which



FIG. 3. J.G. (U-461433) Six days following a right lumbar sympathectomy for Buerger's disease, a thirty-five year old man gradually developed pleuritic pain in the left anterior chest. There was tenderness in the left calf which extended into the left thigh. *Roentgen examination:* Note the area of density in the left lower lobe with slightly elevated left diaphragm. This was considered consistent with an infarct. The lesion gradually healed leaving a linear scar.

Bilateral vein ligation was done, and histopathologic examination revealed a few inflammatory cells in the wall of the vessels.

demonstrate it in at least two different projections. During roentgenoscopy it becomes apparent which positions will best serve this purpose. In addition, roentgenoscopy reveals the dynamics of the chest, the position and motion of the diaphragm, and often diagnostic indications that may not be evident on the roentgenogram itself. The leaf of the diaphragm, for instance, which underlies an infarct in the inferior portion of a lower lobe, is usually elevated and splinted (Fig. 3). A small amount of fluid, often the first sign which requires a search for a small area of consolidation, may be detected more easily by roentgenoscopy than on the film proper.

The so-called spot roentgenogram is taken during roentgenoscopy. This type of roentgenogram, which is better known in examination of the gastrointestinal tract, is equally valuable in examination of the chest for demonstration of an infarct or of

any lesions in the bronchus or lung (Fig. 4). As in the gastrointestinal study, this type of film should be aimed at the lesion. A spot roentgenogram will often afford a better opportunity for study than will the routine large roentgenogram since positioning of some patients to secure the latter may be difficult.

The roentgenoscopic examination, as a rule, is made at a high kilovoltage, approximately 85 to 95 kv., with a low milliamperage giving a low roentgen output. This protects the patient against overdosage while allowing penetration through the heart and giving better study of the dynamics of the chest than at a lower voltage. The spot roentgenogram is taken at the same kilovoltage with very short exposure, the timing usually being done with the foot rather than by means of a timer.

The completion of the roentgenoscopic examination will leave the roentgenologist

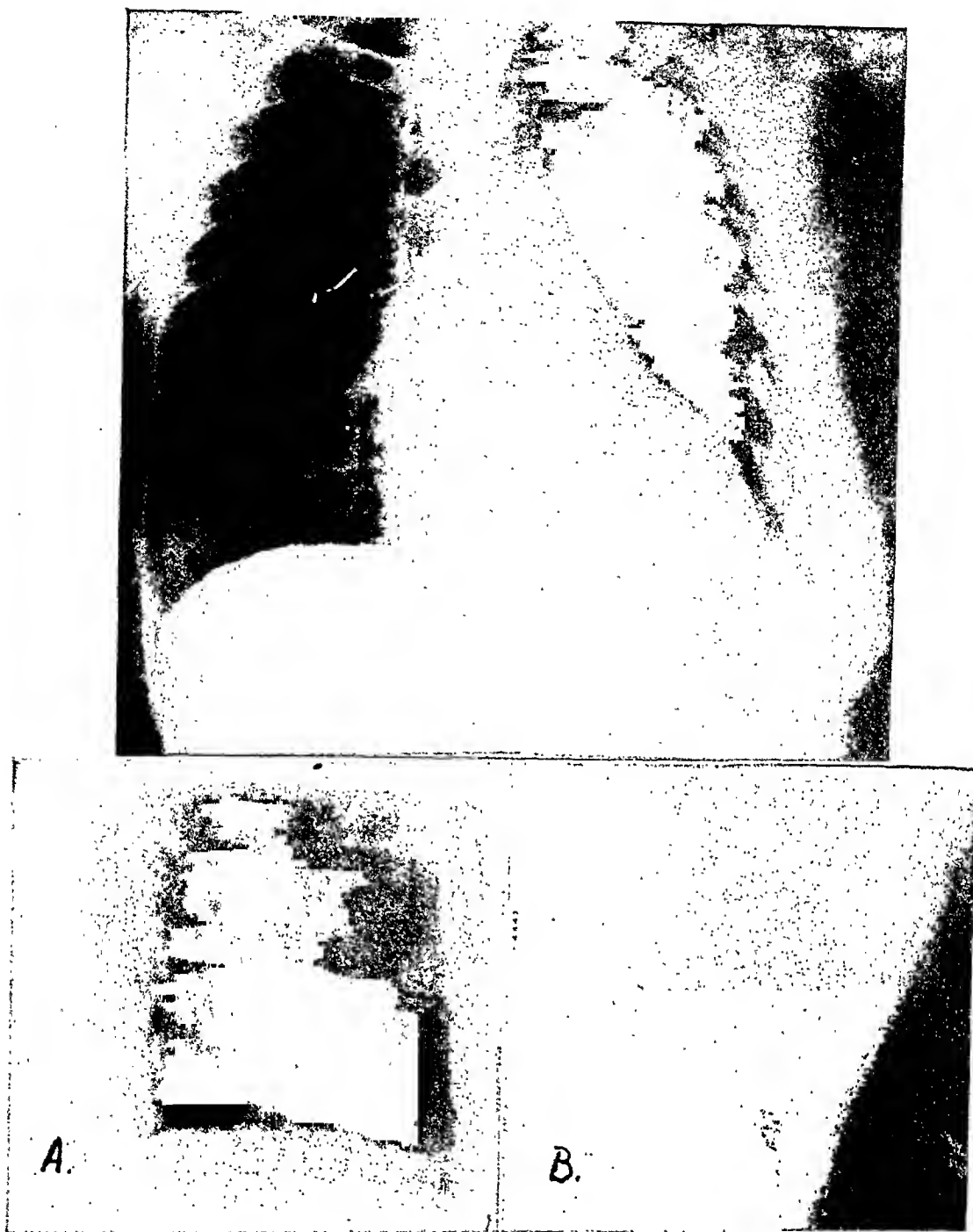


FIG. 4. I.L. (U-432527) Approximately ten days after vaginal hysterectomy, a sixty-three year old woman complained of tenderness in both calves, and ran a slight fever. Several days later she experienced severe pain in the left lower chest. *Roentgen examination:* At this time, the left diaphragm was slightly elevated and showed some limitation in motion. Spot roentgenograms (A) taken at the time of the large roentgenogram better demonstrate the lesion lying just above the left diaphragm. (B) Spot roentgenogram taken several days later shows the linear shape of the infarct as it healed.

Bilateral vein ligation was done, but no clots were found.

with an understanding of the dynamics of the chest and knowledge of what roentgenograms are necessary to demonstrate the lesion. A posteroanterior roentgenogram is always necessary, and if spot roentgeno-

grams have not been made, a lateral view, or oblique view, is requisite (Fig. 5 and 6). Occasionally a single roentgenogram or stereoscopic views will be sufficient to demonstrate an area of density but not the

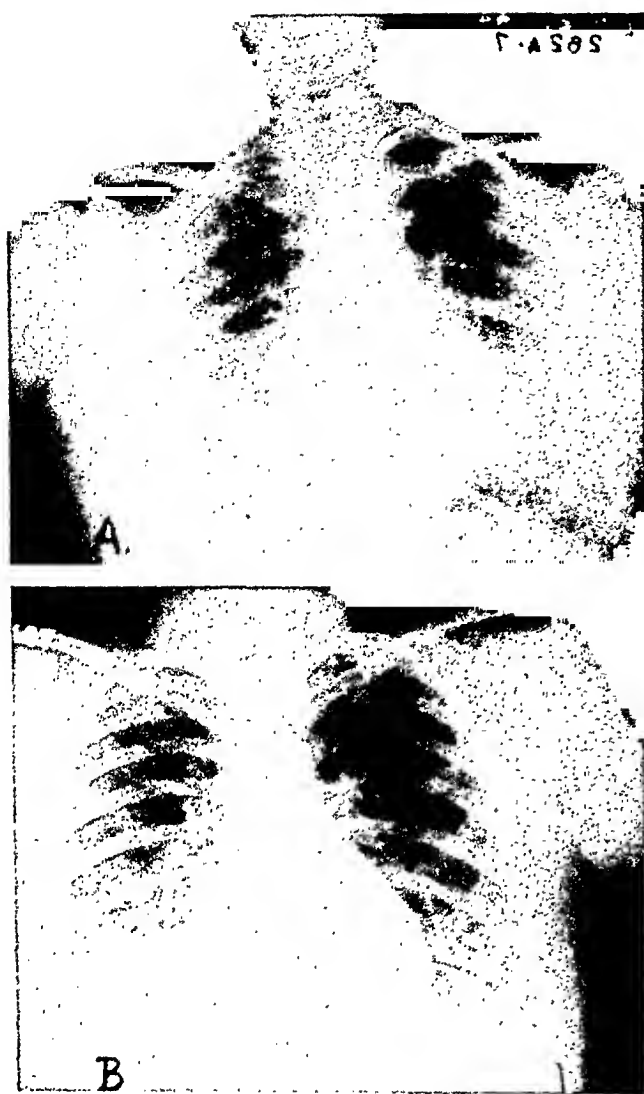


FIG. 5. B.S. (U-262467) A twelve year old boy entered the hospital for removal of a cartilage from the knee. Several days after operation, he complained of pain in the right lower chest and at the same time developed a cough with elevation of temperature, pulse, and respiration. *Roentgen examination:* (A) Portable roentgenogram. No definite shadow suggestive of an infarct could be demonstrated. (B) Posteroanterior view taken in the Department of Radiology three days later does not demonstrate the lesion.

configuration of an infarct. If the patient is too ill to permit roentgenoscopy, a less complete examination must be made. This is often the case in hospital practice. A single anteroposterior and a lateral roentgenogram, the latter being taken with the patient's affected side directed towards the film, must be made to suffice. It has been our good fortune to have at our disposal a ceiling floor mounted tube stand, beneath which it is possible to push a bed and ob-

tain films of excellent quality at a 6 foot distance and with a short exposure time. This has been of aid in obtaining more accurate diagnosis, and has practically eliminated portable films of the chest which are usually not diagnostic of the small infarct. The patient is subjected to no more manipulation than in examination with the portable apparatus and is kept in the department only as long as it requires to make two exposures.

Bronchography and laminagraphy in our experience have not been of value in demonstrating pulmonary infarcts. Furthermore, in most instances the patient is too ill to stand the manipulation required for such unnecessary procedures.

Certain technical factors have proved of sufficient value to warrant further description. The conventional roentgenograms are all taken with a rotating anode tube which provides a small focal spot, with high milliamperage and short exposure time, thus giving excellent detail. The preservation of the 6 foot distance has been of the greatest value in preventing distortion. A modification of Fuchs' technique,⁴ evolved by Oliver E. Merrill, Physicist of the Department of Radiology at this hospital⁷ has been, in our opinion, an advance in pulmonary roentgenology. Using the fundamental ideas of Fuchs—a high or better stated optimum kilovoltage for the part, and variation of milliamperes-seconds with the size of the patient—a roentgenogram of excellent and more uniform quality has been obtained. This improvement over previous roentgenograms is probably due to the fact that a much greater latitude is possible at a higher than at a lower kilovoltage. Fuchs' technique called for shorter distances than 72 inches, but Merrill's modification makes the 72 inch distance possible, and as has been said, it is the maintenance of this distance which we believe is of the utmost importance in demonstrating pulmonary lesions accurately. Continued research has further improved the quality of the roentgenograms and the present factors used are



FIG. 6. (Same case as in Fig. 5.) (A) Lateral view showing shadow in posterior portion of right costophrenic angle hidden behind the right diaphragm. (B) Enlargement of the same area to better demonstrate the shadow of increased density. Note that there is a small amount of fluid posteriorly in the pleural cavity and the posterior few centimeters of the right diaphragm are not visualized.

Although it was believed that the roentgen appearance was consistent with an infarct, the age of the patient made conservative therapy seem advisable. Convalescence was uneventful.

shown in Chart I.⁶

Roentgenograms taken with this technique have a somewhat steel-gray appearance and show less contrast than those taken with a lower kilovoltage. They are, however, undoubtedly of better diagnostic quality and do not have to be retaken as often as formerly because of technical errors.

DIFFERENTIAL DIAGNOSIS

As in the diagnosis of any lesion, the differential possibilities must be studied and the clinical history considered in making the final decision. Pulmonary infarct, particularly in its healing stage, throws a linear shadow at times almost indistinguishable from that of atelectasis. The work of Fleischner, Hampton and Castleman³ has clarified to some extent the differential points in these two lesions. Linear areas of atelectasis, which are frequently multiple in the same chest, are of

short duration and cast a shadow that may extend to the pleura on each side—it is a long shadow, which shows no peripheral nodularity. The shadow cast by a healing or healed infarct, on the other hand, also extends to the pleural surface but at that point a small nodule is visualized: this shadow disappears slowly, often being seen for some weeks.

Occasionally a pulmonary infarct may reduce the size of a lobe. In such a case, the

CHART I

CHEST EXAMINATION

300 ma.

72 in. distance

Size Chest	Posteroanterior		Oblique		Lateral	
	cm.	sec.	cm.	sec.	cm.	sec.
Small	19	1/60	23	1/20	26	1/15
Average	20-25	1/30	24-30	1/15	27-32	1/10
Large	26-29	1/20	31-33	1/15	33-	1/10
Huge	30-	1/15				
	68 kv.		75 kv.		80 kv.	

differential diagnoses must include other conditions, such as primary carcinoma, that also cause diminution in size. It is rare for an infarct to produce segmental collapse.

Bronchopneumonia or metastatic malignancy may be mistaken for infarction. In pneumonia, however, the shadow seldom becomes sharply circumscribed as in infarction nor does it necessarily extend to a pleural surface. Although metastatic malignancy usually throws a rather sharply circumscribed shadow, its size does not decrease over a period of days but instead tends to increase slowly.

Only the common and most confusing problems in differential diagnosis have been discussed, and the discussion has been of utmost brevity. The point it is desired to emphasize at this time is the importance of technical factors in demonstrating a pulmonary infarct.

SUMMARY

The importance of early recognition by the roentgenologist of pulmonary infarction has become increasingly evident as modern methods for preventing and combatting its sequelae, fatal massive emboli, have been developed. The characteristic roentgenologic appearance (shape, size and location) of a pulmonary infarct from its initial to its healing phase has been reviewed. Certain confusing differential points have been described.

Proper technique of the roentgen examination is the important factor in the roentgenologist's ability to demonstrate a pulmonary infarct. For a satisfactory study, the essential points are roentgenoscopy, spot roentgenograms, and roentgenograms taken in the posteroanterior and lateral projections. Diagnostic accuracy has been greatly improved by the use of the modified optimum kilovoltage technique.

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REFERENCES

1. ALLEN, A. W., LINTON, R. R., and DONALDSON, G. A. Venous thrombosis and pulmonary embolism. *J. A. M. A.*, 1945, 128, 397-403.
2. ALLEN, A. W. Thrombosis and embolism. *Bull. New York Acad. Med.*, 1946, 22, 169-184.
3. FLEISCHNER, F. G., HAMPTON, A. O., and CASTLEMAN, B. Linear shadows in the lung (interlobar pleuritis, atelectasis and healed infarction). *AM. J. ROENTGENOL. & RAD. THERAPY*, 1941, 46, 610-618.
4. FUCHS, A. W. Optimum kilovoltage technique in military roentgenography. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1943, 50, 358-365.
5. HAMPTON, A. O., and CASTLEMAN, B. Correlation of postmortem chest teleroentgenograms with autopsy findings, with special reference to embolism and infarction. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1940, 43, 305-326.
6. MERRILL, O. E. Personal communication.
7. ROBBINS, L. L., HALE, C. H., and MERRILL, O. E. Roentgen appearance of lobar and segmental collapse of the lung. I. Technic of examination. *Radiology*, 1945, 44, 471-476.



SIMULATED DEXTROCARDIA ASSOCIATED WITH BRONCHIECTASIS

REPORT OF CASE

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DEXTROCARDIA secondary to fibrosis and retraction of the right lung has been well known for many years especially in chronic fibroid tuberculosis, and also in association with bronchiectasis. Primary or congenital dextrocardia with transposition of the viscera accompanied by bronchiectasis, although quite rare, does occur, too, as recorded by Kerley¹ who cites a number of such cases reported by Kartegener and mentions one of his own that came to autopsy. Furthermore, isolated congenital dextrocardia, without the characteristic electrocardiographic changes of the mirror image type of dextrocardia, has been described by White² (among others). In view of these facts it is believed the following case presents features of sufficient interest to warrant reporting.

REPORT OF CASE

A soldier, white, aged twenty-one, was admitted to this Army General Hospital on October 29, 1944, complaining of shortness of breath on exertion, cough, morning expectoration up to one-half sputum cup daily, occasionally blood streaked, and pain in the right chest.

He gave a history of "rheumatic fever and pericarditis" at the age of eight or ten, which confined him to bed for quite a number of weeks; a year later he developed whooping cough, followed by chronic cough and expectoration ever since. In addition, about once a month during the winter, attacks of sore throat, cough, dyspnea and fever would develop. From the time of his "rheumatic fever," his physical activities were somewhat restricted.

In 1941, after a routine examination for employment, including a chest roentgenogram, he was told he had dextrocardia, but was accepted.

In December, 1942, and again in July, 1943, he was rejected by the Army because of dextrocardia and pericarditis (patient's statement). (Incidentally complete examinations, including

electrocardiograms, were made at a civilian hospital after these rejections but no report of the findings was given him.)

In September, 1943, after a paroxysm of coughing, hemoptysis of a cupful of dark red blood occurred. Nevertheless in November, 1943, after a physical examination by an internist, the patient persuaded the latter to give him a letter to the induction board recommending acceptance. Following this he was re-examined by the Army, accepted, and on December 1, 1943, inducted.

Throughout his Army service dyspnea on exertion has been his chief difficulty. After two weeks' basic training, he was hospitalized for observation because of dyspnea but was returned to duty in two weeks. In April, 1944, he again entered the hospital, this time for nasopharyngitis, the symptoms being much like his usual winter attacks. Later that same month he was treated for cellulitis and abscess in the left inguinal region following injury.

Overseas the dyspnea became more marked, particularly in combat, when he was unable to run even in the face of enemy fire. Finally on October 11, 1944 (after the engagement at Brest) he was sent to an aid station and thence to various hospitals until he reached this hospital. At an evacuation hospital a roentgen report of October 12, 1944, stated in part "—mediastinum and cardiac shadows shifted right, right heart border similar to that seen on left. This may be true dextrocardia or only apparent." At a general hospital his chief complaints again were dyspnea and pain in the right chest as if something were squeezing him. His temperature was elevated to 102° F. for one day, then subsided. A roentgenogram of the chest was interpreted as showing an isolated dextrocardia, partly rotated probably congenital; an electrocardiogram was normal. Patient was returned to the United Kingdom for further study and admitted to this hospital on October 29, 1944.

The essential physical findings were: (1) moist medium râles over lower third of right lung, with fine râles at the left base; (2) heart



FIG. 1. Roentgenogram showing dextroposition of heart; shift of mediastinum to right; S-shaped line at right base (displaced primary fissure); pleuro-pericardial adhesions on right.

on right but greatest intensity of heart sounds in mid-sternal region with equal transmission to either side; (3) no murmurs or thrills were present; (4) cardiac reserve was good. Blood pressure 112/85; heart rate 82; (5) no cyanosis and no clubbing of fingers.

Laboratory Findings. Sputum—half cup of gray sputum daily with pneumococci predominating on culture. Sputum did not form layers on standing and had no perceptible odor. In the examination of the blood, the Kahn reaction was negative; erythrocyte count and sedimentation rate normal; leukocyte count 11,450 and 13,150 with a differential count of 53 per cent polymorphonuclears, 43 per cent lymphocytes, 3 per cent eosinophiles and 1 per cent monocytes. Urinalysis was negative; electrocardiogram, negative (as on examination prior to admission).

Roentgen Findings.

(1) Right-sided heart, mediastinum shifted to right, some narrowing of right hemithorax and slight elevation of right diaphragm.

(2) Emphysema localized to lower half of right lung (middle lobe on lateral view).

(3) Marked downward and backward displacement of right primary fissure, with some twisting—so that the fissure appears as S-shaped linear density extending from extreme tip of right cardiophrenic angle to lower right heart border, with convexity upward, medially and superiorly, and downward, laterally and inferiorly (Fig. 1).

(4) Curved bands of adhesions extending from medial third of right diaphragm to upper right heart border.

(5) Barium-filled gastrointestinal tract normal in position.

(6) Bronchogram showing marked tubular bronchiectasis of right lower lobe affecting the posterior basal branches chiefly, with sac-like collections more laterally at the base. Marked retraction of the right lower lobe as shown by crowding of the bronchi; also slight bronchiectasis of right middle lobe (Fig. 3 and 4); saccular bronchiectasis of left lower lobe medially.

(7) On roentgenoscopy slight rotation produced almost normal cardiac configuration with aortic arch clearly seen on left, and left heart border demonstrated just to left of mid-



FIG. 2. Dorsal and downward displacement; emphysema of right middle lobe.



FIG. 3 and 4. Marked bronchiectasis and retraction of right lobe; slight bronchiectasis of right middle lobe.

line. This was confirmed by a roentgenogram made with the same degree of rotation (Fig. 5).

DISCUSSION

These roentgen studies demonstrate clearly that neither situs inversus nor transposition of the cardiac chambers is present. Not so readily disposed of is the possibility of an isolated congenital dextrocardia, suggested by a previous examiner. At this point a brief consideration of the various types of congenital dextrocardia is in order. Two types of the "isolated" form are known; the first without and the second with transposition of the chambers. In the other group, transposition of the chambers occurs with complete or partial situs inversus. (Thus "mirror image" or dextrocardia with transposed chambers may occur with or without transposition of the viscera.) The first form of isolated dextrocardia consists of a right-sided heart, slightly rotated, with the left chambers to the left and anterior, and the right chambers to the right and posterior; and the apex is made up of the right ventricle, or the right side of the common ventricle.²



FIG. 5. True relation of cardiac chambers, without transposition demonstrated by slight rotation of patient (pleuropericardial adhesions seen more clearly).

White further states that in this type almost invariably some serious associated congenital anomaly, like a single ventricle, is present. The second or mirror image type of isolated dextrocardia is also said not to occur without other more important congenital cardiovascular defects. White and Kerley both refer to the work of Roesler in 1930 in this connection. Kerley mentions two such cases of his own, with transposition of the chambers but not of the aorta—one of these was found at autopsy to have gross defects of the interventricular and interauricular septum. These had been suspected clinically but were not revealed by roentgen examination. I have also seen a case of isolated "mirror image" dextrocardia in a colored woman (a WAC applicant) with other congenital anomalies (such as ten ribs, and absence of vagina). No other cardiac abnormality was demonstrated and the electrocardiogram was normal.

No statistics on the incidence of electrocardiographic findings in the various congenital dextrocardias just mentioned appear in the references available to me at this time. It has been established that the pathognomonic pattern—an inversion of all the complexes in Lead 1, with Lead 2 resembling the customary Lead 3, and Lead 4 like the usual Lead 2—is found in "mirror image" dextrocardia accompanied by complete situs inversus. Ashman and Hull⁴ state that similar patterns occur in "mirror image" dextrocardia with situs inversus, but because of the usual association with other cardiac anomalies the picture is often bizarre. In the group of isolated dextrocardias without transposition of the chambers (classified as one of the main groups by White) it seems evident that any electrocardiographic changes would depend on the associated cardiac abnormalities present.

The present case obviously resembles the first type of isolated dextrocardia, namely without transposition of the chambers. However, it is believed that the rotation and dextroposition of the heart are sec-

ondary to the marked retraction of the right lower lobe, shifting of the mediastinum and pleuropericardial adhesions. Further support of this contention is the absence of any other cardiac abnormality. On similar grounds the S-shaped line at the right base is interpreted as a displaced and distorted primary fissure, not ordinarily seen on the posteroanterior view. On the other hand, it may be maintained that this S-shaped line represents the displaced fissure of an inferior retrocardiac accessory lobe—which may be the site of an atelectatic bronchiectasis as demonstrated by Kerley; Kerley cites similar observations by others including Richards. In the present instance, the history and roentgen findings render the explanation of a displaced primary fissure more likely.

Another point deserving mention is the presence of a marked localized emphysema which has been emphasized by Twining¹ as an indication of atelectatic bronchiectasis of the lower lobe. The bronchiectasis of the right lower lobe revealed in this case appears to conform to this type of bronchiectasis as described by Twining. It is interesting to note, however, that in spite of the advanced changes, this is a relatively dry case of bronchiectasis with very little expectoration and the condition could well be simulated by congenital bronchiectasis (which is also dry) with mediastinal shift.

In conclusion, the sequence of events appears to have been pulmonary infection in childhood, followed by bronchiectasis; retraction of right lower lobe, emphysema of the right middle lobe and pleuropericardial adhesions combined to produce dextrocardia with some cardiac rotation. Twining states that probably the majority of atelectatic bronchiectasis in a lower lobe are of the acquired type and the sequence is collapse, infection, bronchiectasis—not bronchiectasis followed by collapse. In this case unfortunately the early history is indefinite and no roentgenograms are available to demonstrate collapse of the right lower lobe which may have been present at the onset.

SUMMARY

(1) A case of apparent dextrocardia is demonstrated to be secondary to atelectatic bronchiectasis and retraction of the right lower lobe with additional factors of emphysema of the right middle lobe and pleuropericardial adhesions contributing to rotation.

(2) Other conditions to be considered in the differential diagnosis are discussed briefly, namely:

(a) Primary dextrocardia with transposition of the viscera associated with bronchiectasis.

(b) Isolated congenital dextrocardia (with bronchiectasis).

(c) Congenital bronchiectasis with mediastinal displacement.

(d) Bronchiectasis of a retrocardiac inferior accessory lobe.

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REFERENCES

1. SHANKS, S. C., KERLEY, P., and TWINING, E. W. Textbook of X-Ray Diagnosis. H. K. Lewis & Co., Ltd., London, 1939. Reprinted, 1943. Pp. 51, 185, 190, 196.
2. WHITE, P. D. Heart Disease. Second edition. Macmillan Co., New York. Reprinted, 1942. Pp. 200, 205.
3. Nomenclature and Criterion for Diagnosis of Disease of the Heart. New York Heart Association, 1942. Pp. 42, 95.
4. ASHMAN, R., and HULL, E. Essentials of Electrocardiography for the Student and Practitioner of Medicine. Second edition. Macmillan Co., New York, 1941, p. 279.



A CASE OF DIVERTICULOSIS OF THE VERMIFORM APPENDIX ROENTGENOGRAPHICALLY DEMONSTRATED

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DIVERTICULOSIS of the appendix is occasionally seen by the pathologist. However, the diagnosis is rarely made pre-operatively. We wish to report the following case in which diverticula were visualized in the appendix during a gastrointestinal examination and later confirmed at surgery.

CASE REPORT

This soldier, white, aged twenty-five, was admitted to the hospital complaining of right lower quadrant abdominal pain, localized at McBurney's point. The patient stated that for the past two years he had had frequent similar attacks of pain in the right lower quadrant. The attacks lasted for one or two weeks, followed by remissions of about two months. The pain was rather severe and well localized. Partial relief was obtained by flexing the thigh on the abdomen. He had been hospitalized once previously for the same complaint but was discharged without surgery. The present attack of pain began about four days previous to admission and became progressively worse. There was no history of constipation, diarrhea, nausea, or vomiting. The review of systems was, otherwise, essentially negative. The family history was irrelevant. Previous history was likewise irrelevant.

Upon admission, the abdomen was soft and flat. There was tenderness in the region of the cecum, extending upward along the usual course of the ascending colon. The tenderness was more marked over McBurney's point. Rectal examination with bimanual palpation revealed a small very tender mass in the cecal region. Admission blood count revealed: erythrocytes, 4,450,000; leukocytes, 8,100; hemoglobin, 90 per cent, with neutrophils 76 per cent, lymphocytes 20 per cent, monocytes 4 per cent. A routine urinalysis was essentially negative. The blood Kahn reaction was negative.

Roentgen studies of the colon were made by means of a barium enema and a twenty-four hour roentgenogram after ingestion of contrast

medium. The colon filled readily on the retrograde study, without evidence of gross deformity or delay. There appeared to be slight irritability of the ascending colon. A small rounded projection defect extended from the appendix near the junction of the mid and distal thirds. This was considered to be a small diverticulum. Another, more questionable, diverticulum was visualized in the same region.

Examination of this patient's colon twenty-four hours after ingestion of an opaque meal showed a very small amount of barium in the appendix, insufficient for complete visualization. However, there was definite subjective tenderness, localized medial to the cecum in a position which was occupied by the appendix when filled. The appendix extended from the cecal tip obliquely upward, the same position shown on examination three months previously. The cecum was not freely movable, and, inasmuch as the appendiceal position was somewhat unusual and, apparently, had been maintained over a period of months, it was assumed that the appendix was fixed in the position described and that the subjective tenderness was attributable to some type of pericecal or peri-appendiceal pathologic change.

On the basis of the clinical findings, supported by the roentgenological findings, appendectomy was performed on May 3, 1945. The cecum was found to be fixed. The appendix was retrocecal, retroserosal and fixed. The serosal veil of the cecum was dissected from the appendix and the appendix carefully removed.

The pathologic examination of the appendix was reported by the pathologist, as follows:

Gross: The specimen is a curved appendix with a total length of 8 cm. and an average diameter of 0.6 cm. The serosal surface appears slightly congested, but is smooth and glistening. Along the medial concave border, where a small amount of meso-appendix is included, the wall shows three distinct nodular bulgings, of roughly hemispherical shape, but attached to the appendix along a broad base 6 to 8 mm. across.

"Incision is made through the bulgings. The two distal swellings are similar. They disclose a definite lumen filled with soft brown fecal material, and continuous with the main lumen of the appendix, which is also so filled. The wall is markedly thinner around these diverticula than in the main portion of the appendix, and the muscularis can be seen fading off to nothing. The most proximal swelling, on incision, shows no communication with the central lumen. At this level, the lumen is only a narrow slit in the

short distance. In the diverticulum proper, a band of muscle fibers is present immediately beneath the mucosa, forming a distinct muscularis mucosae continuous with the muscularis mucosae of the appendix proper, but much more prominent. External to this, there is a thin layer of fibrous and adipose tissue, containing numerous lymphocytes. It is probable that a few delicate muscle fibers persist within this fibrous investment.

"Diagnosis: Diverticula of appendix, with

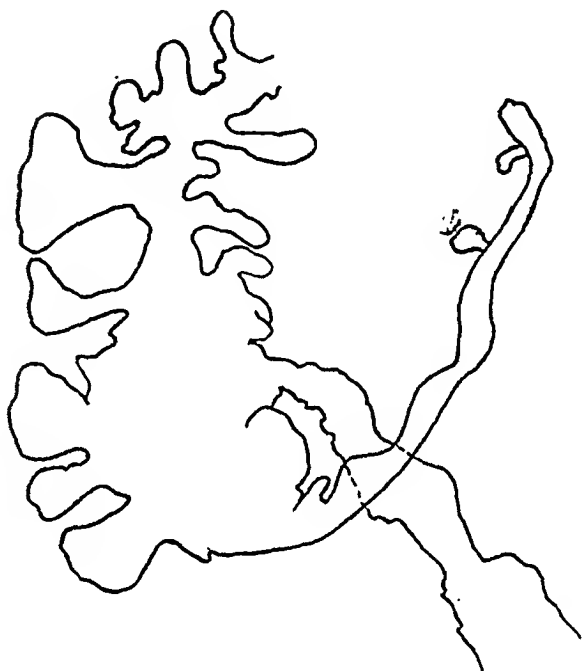


FIG. 1. The terminal ileum, cecum with attached appendix and ascending colon are shown as visualized on the post-evacuation roentgenograms, made at time of colon examination by barium enema. Two small diverticula may be seen projecting from the medial aspect of the appendix as designated in diagram.

main appendix, while the diverticulum is filled with soft brown fecal material. The wall of the diverticulum is considerably thicker than in the other distal examples.

"Microscopic: Sections through the appendix and diverticula show a dumb-bell shaped lumen filled with fecal material. Leukocytes are not present. The mucosa is everywhere intact but relatively narrow. In the main part of the appendix there is a moderate amount of lymphoid tissue in the submucosa. The muscularis, of average width, has a horse-shoe shape. At the beginning of the diverticulum, the muscle fibers spread out thinly and extend downward around the diverticulum for a very

very slight chronic inflammatory reaction."

The patient made an uneventful recovery and was discharged to duty on May 21, 1945.

Follow-up examination, July 21, 1945, was made. The patient volunteered the information that he felt fine and had had no more abdominal complaints since he was discharged from the hospital. He further stated that, prior to his surgery, any walking induced an attack similar to those described in the admission history, but now he can walk long distances without abdominal discomfort.

DISCUSSION

The incidence of diverticula of the ap-



FIG. 2. Surgical specimen—appendix. Three diverticula are shown projecting into the meso-appendix.

pendix has been variously estimated at less than 0.5 per cent, to as high as 5 in 264 appendices (1.89 per cent) reported by Stout.¹ In this hospital, the pathologist found 4 in 1,850 appendices (0.22 per cent).

The demonstration, preoperatively, by means of roentgen examination, is apparently much more rare than the above statistics indicate. Feldman² states that he did not demonstrate any in 20,000 gastrointestinal examinations. He quotes Spriggs and Marxner as having demonstrated appendiceal diverticula in 6 cases and Edwards, in 2 cases. Kadrnka and Sarasin³ reported a roentgen study of 2 cases in which diverticula were found incidentally. In neither case were there symptoms referable to the right lower quadrant. We have found 1 case in a series of 3,932 gastrointestinal examinations.

Pathologically, all diverticula of the appendix are considered to be of the "acquired" type, there being two groups: (1)

those that occur through defects for the passing of the vessels supplying the submucosa and mucosa in the muscular coats, and (2) those which occur through defects in the muscularis due to acute inflammatory processes.¹ It is not our purpose to discuss the pathological morphology, ex-



FIG. 3. True cross section of appendix on plane through middle diverticulum. Appendiceal lumen above; meso-appendix below.

cept to point out that our case, apparently, belongs in group (1), since evidence of chronic inflammatory change in the appendix was minimal.

The authors are indebted to Dr. Lester S. King, now pathologist at Illinois Masonic Hospital, Chicago, Illinois, for the pathologic material used in this case report.

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REFERENCES

1. STOUT, A. P. Study of diverticulum formation in the appendix. *Arch. Surg.*, 1923, 6, 793-829.
2. FELDMAN, M. Clinical Roentgenology of the Digestive Tract. Second edition. Williams & Wilkins Co., Baltimore, 1945, p. 567.
3. KADRKA, S., and SARASIN, R. A propos de deux cas de diverticules appendiculaires. Examen radiologique. *Bull. et mém. Soc. de radiol. méd. de France*, 1932, 20, 321-325.

A CYLINDRICAL RADIUM APPLICATOR FOR THE TREATMENT OF SURFACE VAGINAL LESIONS*

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THE design of a radium applicator intended for vaginal neoplasms, like most radiotherapeutic instruments, should meet the following requirements:

- (a) accurate placement and immobilization of the radiating sources.
- (b) uniformity of dosage over the lesions.
- (c) adaptability to varying size, extent and location of lesions in organs of different anatomical dimensions.
- (d) adequate protection of healthy tissue.
- (e) minimum exposure to the persons involved in its preparation and use.

These desiderata, except (c) and (e) can be satisfied by suitable mouldages in which radium tubes are inserted to fit the individual patient.¹

The applicator herein proposed, while not ideal, meets all conditions to a large degree. It must be regarded, however, as a versatile one only in the treatment of superficial lesions limited to the lower three-quarters of the vagina. It consists essentially of two parts, a transparent sheath and a lead core, both illustrated in Figure 1, and shown in cross section in Figure 2.

The sheath consists of a lucite cylindrical tube closed at one end. On its external surface there is permanently scratched a cross-sectional pattern consisting of labelled straight lines parallel to the axis of the shell and of numbered circles perpendicular to them.

The core consists of a lead cylinder on the surface of which a suitable number of longitudinal slots have been milled to accommodate the radium. It is provided with a handle and with a thin transparent cover of plastic permanently attached to it, as shown in Figure 1. This complete core slides into the outer case through a pin-and-

slot arrangement. The core envelope is marked similarly to the outer sheath and both sets of markings coincide when the core is fully inserted. It is well to mention here that the straight lines are parallel to the axis of the radium tubes and that the circular scratches are spaced at intervals equal to the length of the radium tubes.

The procedure for determining the portion and the area of the applicator to be

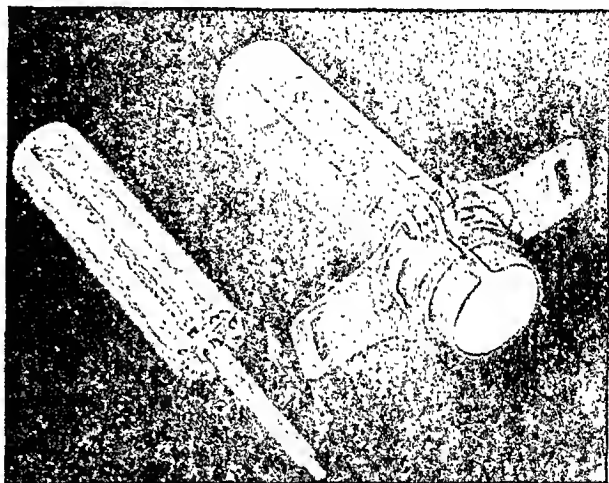


FIG. 1. Transparent sheath and cylindrical lead core shown filled with radium tubes.

filled is as follows. The outer sheath is properly placed in the vagina and, with the aid of a headlight and a laryngeal mirror, the contour of the lesion is inspected through the wall of the plastic tube (Fig. 3). The area covered by the tumor is determined by noting its relationship to the longitudinal and circular marks on the plastic sheath. Since the radium tubes will lie under the longitudinal lines between the circular ones, care is taken to note what lines will extend to or slightly beyond the edges of the cancer. The inner core is then filled by the technician as directed by the

* Read at the Twenty-eighth Annual Meeting, American Radium Society, San Francisco, Calif., June 28-29, 1946.

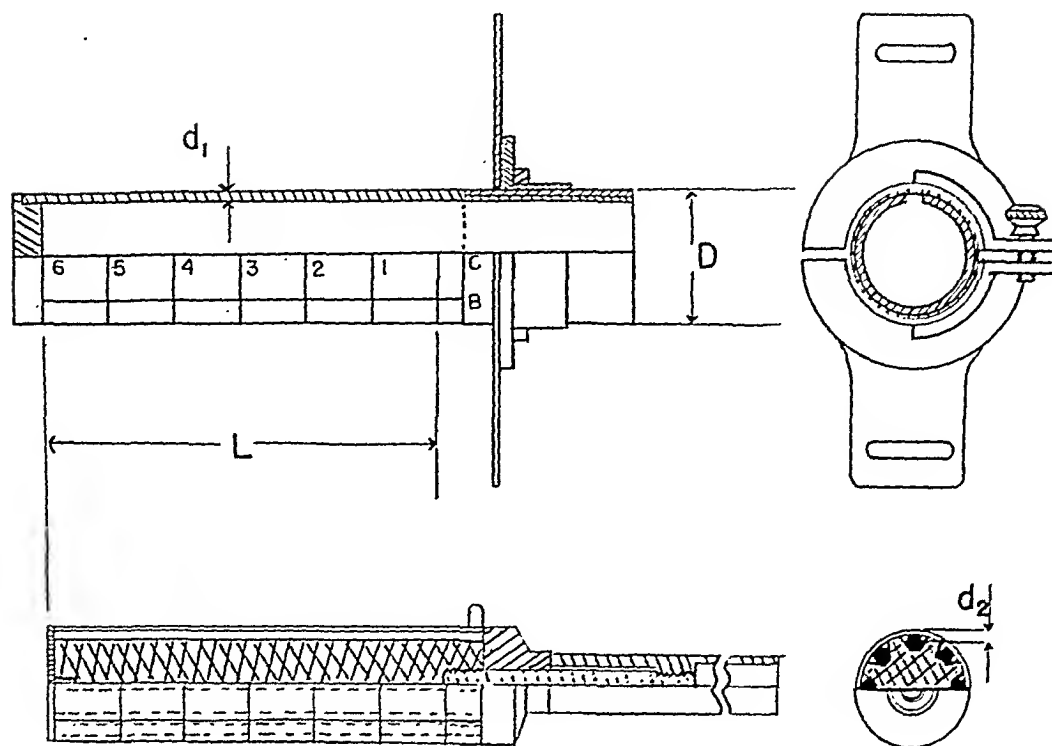


FIG. 2. Cross-section drawing. $L=9.0$ cm., $d_1=0.3$ cm., $d_2=0.35$ cm. Large applicator: 8 longitudinal slots, $D=3.0$ cm. Medium applicator: 6 longitudinal slots, $D=2.5$ cm.

examiner. The tubes are positioned with the use of dummies in the unoccupied spaces in the core. Since they are discernible from the outside, their position is checked visually by inserting the core into the sheath before delivery to the therapist.

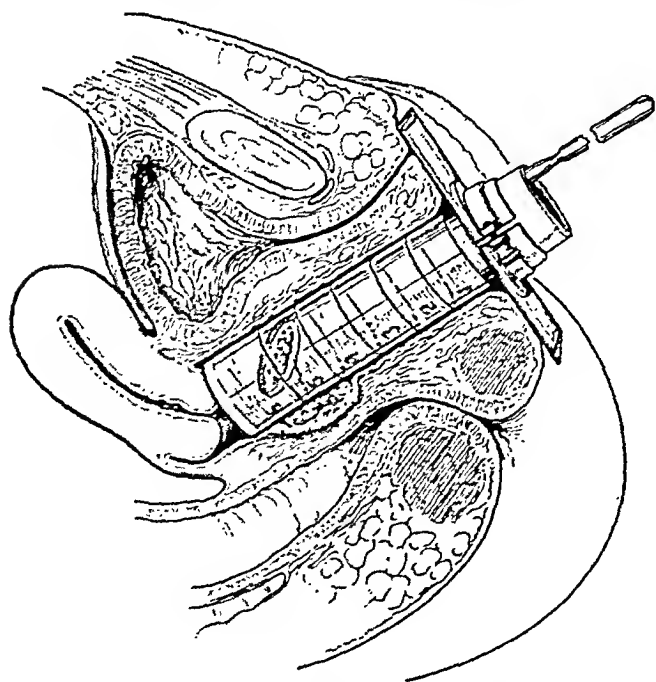


FIG. 3. Cross section of the female pelvis with the outer sheath of the applicator in position, showing how the tumor is visualized with a laryngeal mirror through the transparent lucite wall.

When treatment is given, the outer shell alone is first carefully fitted in the vagina, as was done when determining the area covered by the tumor. The position is checked again with the headlight and the mirror. The shell is then immobilized by means of a split collar provided with slotted flanges which can be secured with a T belt. When this operation is completed, the loaded core can be placed in it (Fig. 4) with

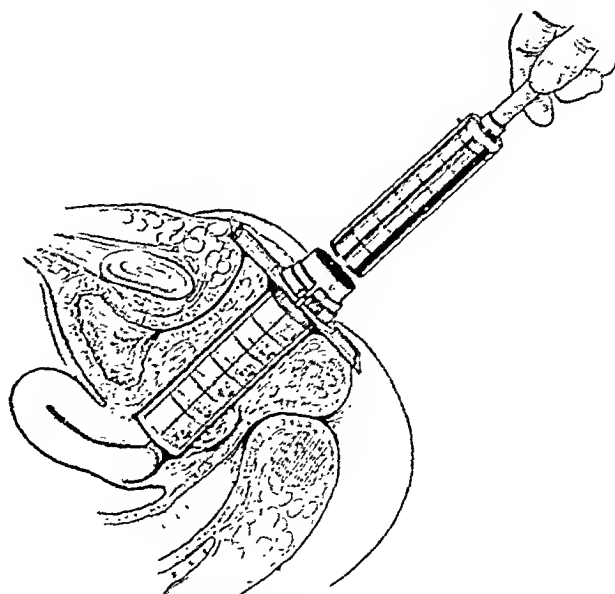


FIG. 4. Core loaded with radium tubes being inserted into the vaginal sheath.

complete assurance as to the accuracy and permanence of position of the radium and with a minimum of exposure to the therapist.

Three sizes of the applicator have been made and the dimensions of the two larger ones are indicated in the legend of Figure 2. The large one, 3 cm. in diameter, accommodates eight slots, and the medium one, 2.5 cm. in diameter, six slots of radium tubes. A smaller type, not shown, is 2 cm. in outer diameter and accommodates three slots in a semicircle; it has been used only in cases of very extensive stenosis. No other sizes have been required by our Gynecological Service.

It can be readily appreciated that the arrangement of parallel tubes on a cylindrical surface can lend itself to innumerable sizes and locations of lesions. Dosage calculations, however, cannot be easily adapted from published data on account of the presence of the lead core and of the impossibility of placing tubes at right angles to each other.

The relationship between exposure (mg.-hr.) and dosage in space (r) was determined experimentally for a single tube by means of roentgenographic films and a bakelite phantom. The latter, shown in Figure 5, consisted of concentric tubes of bakelite spaced to accommodate the films and to average unit density over the whole mass. The entire applicator was placed in the center, the first film immediately on its surface, the others at proper distances up to 3 cm. beyond. The usual precautions necessary for this type of work, namely simultaneous processing of all films and calibration under standard conditions, were observed. Thus roentgens were computed on the basis of 8.4 r per mg.-hr. at 1 cm. from a point source filtered by 0.5 mm. of platinum. Control standardization of film (density vs. roentgens) was carried out with a radium standard at 7 cm. from the film, the latter covered by $\frac{1}{8}$ inch bakelite on both sides. Densities were measured with a Marshall transmission densitometer. Exposure times in the phantom were adjusted

to yield readings on the most convenient portion of the *I-D* curve of the film.

Once the spatial distribution from a tube was satisfactorily determined and found essentially independent of the position of the radium source in the slot, the study was extended to several combinations of tubes by mapping the surface of the sheath rolled

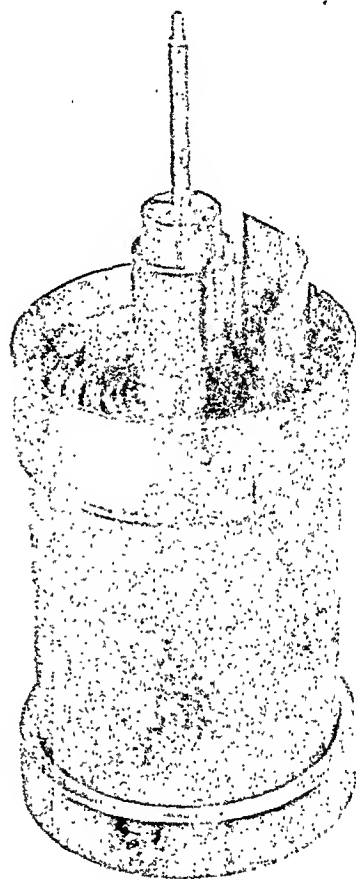


FIG. 5. Bakelite phantom used to determine distribution of radiation by use of films.

out on a plane. Under this condition the lettered slots and numbered rings of the sheath will be represented by intersecting lines. The experimentally determined dose from one tube to a given position can then be read at these intersections and added to the doses from other tubes situated elsewhere. This calculation was carried out at the surface of the applicator and 0.5 cm. beyond.

To cover the field systematically, the calculations were first made for an area one tube long and two slots wide; then for the

TABLE I
MEDIUM APPLICATOR

A	CM ²	S	D	A	CM ²	S	D	A	CM ²	S	D
I	0.5	50	165	II	1.5	8	240	I:I	2.5	105	300
I I	1.0	85	240	II II	2.0	130	330	I:I I:I	4.0	165	410
I I I	1.5	120	300	II :: II	4.0	175	430	I:I ::: I:I	8.0	220	485
I I I I	2.5	155	370	II II II II	5.5	215	480	III I:I I:I III	11.5	245	590
I I I I I	4.0	190	425	II II II II II	7.5	265	570	III I:I I:I I:I III	16.0	335	725

A	CM ²	S	D	A	CM ²	S	D	A	CM ²	S	D
IIII	4.0	120	327	IIII	5.5	145	375	IIIII	7.5	155	395
I::I I::I	6.0	190	460	IIII IIII	7.5	200	470	IIIII IIIII	11.5	265	520
IIII I::I IIII	11.5	255	550	IIII I:::I IIII	15.0	295	516	IIIII :::~: IIIII	23.0	315	665
IIII I::I I::I IIII	17.0	320	685	IIII I:::I I:::I IIII	22.5	360	750	IIIII :::~: :::~: IIIII	34.0	375	790
IIII I::I I::I I::I IIII	23.0	380	770	IIII I:::I :::~: I:::I IIII	31.0	430	825	IIIII :::~: IIIII :::~: IIIII	45.0	425	890

A: Arrangement of tubes in rows and columns
CM²: Surface area.
S: Milligram-hours per 1,000 r at surface.
D: Milligram-hours per 1,000 r at 0.5 cm. depth.

same height three slots wide, etc., until a ring one tube high was completed: the calculations were then repeated for an area two tubes in length and two slots in width, and so on until a length of five tubes or 7.5 cm. was filled.

At the beginning, for practical reasons, it was decided to use in these applicators tubes of strengths in the ratio of 2:1 (in our case 50 and 25 or 25 and 12.5 mg.) and by a cut-and-try method the most satisfactory arrangement of tubes for the uniform dos-

TABLE II
LARGE APPLICATOR

A	CM²	S	D	A	CM²	S	D	A	CM²	S	D	A	CM²	S	D	A	CM²	S	D
I	0.5	85	210	II	1.5	120	270	I:I	2.5	160	330	I::I	3.5	195	400	I:::I	5.0	230	475
I				II				I:I				I::I				I:::I			
I	1.0	145	280	II	3.0	195	350	I:I	6.0	250	435	I::I	9.0	300	510	I:::I	11.0	340	590
I				II				I:I				I::I				I:::I			
I	1.5	190	355	II	5.0	265	475	I:I	9.0	310	525	I::I	14.0	385	630	I:::I	18.0	430	715
I				II				I:I				I::I				I:::I			
I				II				I:I				III				IIII			
I	2.5	235	445	II	6.0	320	590	I:I	15.0	400	650	I::I	19.0	465	780	I:::I	24.0	535	890
I				II				I:I				III				IIII			
I				II				III				III				IIII			
I	4.0	280	520	II	8.0	360	635	I:I	18.0	460	755	I::I	25.0	560	900	I:::I	33.0	625	1010
I				II				I:I				I::I				I:::I			
I				II				III				III				IIII			

A	CM²	S	D	A	CM²	S	D	A	CM²	S	D
I:::I	6.5	255	525	I:I:I:I	7.5	275	540	IIIIII	10.0	290	575
I:::I				I:I:I:I				IIIIII			
I:::I	14.0	380	660	I:I:I:I	16.0	390	680	IIIIII	20.0	400	695
IIII				IIIIII				IIIIII			
I:::I	23.0	490	805	I:::I	27.0	525	890	IIIIII	36.0	560	910
IIII				IIIIII				IIIIII			
II::II				IIIIII				IIIIII			
I:::I				I:::I				IIIIII			
I:::I	30.0	605	1000	I:::I	36.0	590	1030	IIIIII	48.0	665	1110
II::II				IIIIII				IIIIII			
IIII				IIIIII				IIIIII			
I:::I				I:::I				IIIIII			
I:::I	40.0	710	1150	IIIIII	48.0	770	1250	IIIIII	65.0	800	1335
I:::I				IIIIII				IIIIII			
IIII				IIIIII				IIIIII			

A: Arrangement of tubes in rows and columns.

CM²: Surface area.

S: Milligram-hours per 1,000 r at surface.

D: Milligram-hours per 1,000 r at 0.5 cm. depth.

age distribution over a given area was devised.

The final results are shown in Table I for the medium applicator and in Table II for the large one. In the column marked *A*

the full lines and the dotted lines represent tubes of double and single strength respectively. The column marked CM² gives the size of the lesion conveniently covered by this radium configuration.

In the next columns the exposures in milligram-hours are given for a dose of 1,000 r at the skin surface and at 0.5 cm. depth respectively.* Both dosages are uniform, in most arrangements, to within ± 5 per cent throughout the area limited by the mid-points of the corner tubes, and to within 10 per cent in the rest. In practice, after the tumor outline has been determined, the radium is placed to cover the

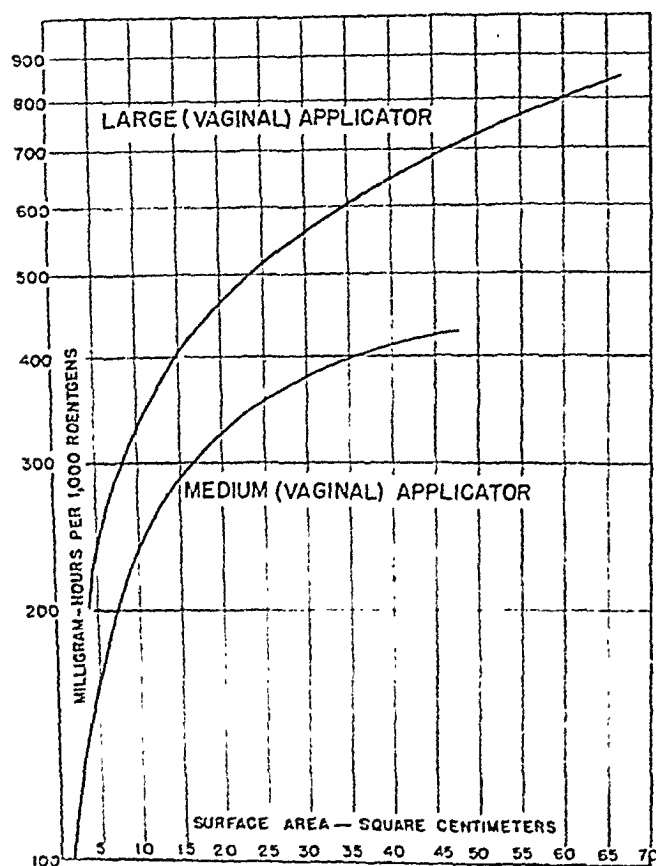


FIG. 6. Curves giving exposure in milligram-hours to produce a dose of 1,000 r at the surface of areas indicated.

nearest rectangle which will extend just beyond the boundaries of the tumor. If the lesion extends beyond the borders of a rectangle but not throughout the length of one side, one or more tubes should be used to cover it. In this case, as well as in the one of very irregularly shaped lesions, a fairly uniform treatment can be given by

measuring the area encompassed by the tubes and by determining the exposure (in mg-hr.) necessary to deliver a given dose in roentgens with the aid of the curves shown in Figure 6. Thus, if a lesion 35 cm.² is to be given 5,000 roentgens with the medium applicator, the appropriate curve of Figure 6 shows that an exposure of 400 mg-hr. corresponds to a dose of 1,000 r. Hence a dose of 5,000 r will be obtained with an exposure of

$$\frac{5000}{1000} \times 400 = 2,000 \text{ mg-hr.}$$

Figure 6 has been

drawn on the basis of the rectangular arrangements shown in the tables. Its validity for irregularly shaped lesions is approximate and requires placement of stronger sources on the periphery and weaker sources in the interior.

To date there are 30 patients whose subsequent records are available to assess the early results obtained with this applicator. The most numerous group and the one in which the most satisfactory results have been obtained are 11 cases of primary carcinoma of the vagina. Of these, 9 are alive and 2 are dead. Of the 11 cases, 7 showed prompt regression of the local lesion with no evidence of recurrence to date. In 2 of these 7 distant metastases in nodes appeared subsequently. In general, the failure to control the primary tumor in 4 cases seemed to be due to the wide extent of the lesion at the time of treatment.

Ten cases of advanced carcinoma of the cervix with extension down the wall of the vagina have been treated by the applicator. Of these, 9 are dead and 1 has been treated within the last six months and the outcome remains in doubt. In 3 cases the vaginal cancer regressed completely after the treatment. In other cases the result of the treatment was hard to evaluate since the patients rapidly deteriorated from extension of their primary tumor into the parametria or from other complications of advanced cancer of the cervix. Little information can be obtained from this group since the prognosis in such cases is almost always very poor. At least the applicator adds one

* The reader is reminded that the dose is expressed in roentgens and that the exposure is expressed in milligram-hours. The dose depends not only on the exposure but also on the geometrical configuration and on the filtration. Therefore the relationship between them must, in general, be established in each instance.

more logical method of treatment of vaginal extensions in this type of advanced cancer.

The remaining 9 cases consist of 4 who had vaginal metastases from cancer of the corpus, in 2 of which the local lesions were controlled, 2 cases of cancer of the urethra, 1 of which has been cured to date, and a case each of endometrial sarcoma metastatic to the anterior vaginal wall, carcinoma of the rectum metastatic to the vagina, and Hodgkin's disease involving the anterior vaginal wall and urethra. All 3 of the latter cases are still alive; the ultimate result of the vaginal treatment remains still in doubt.

For the therapist who desires to avail himself of our experience in using this form of radium applicator, a word should be added as to the dosage used. This has ranged from 3,200 r to 11,300 r on the surface with a single application. The tendency of late has been to give repeated doses a week or two weeks apart, the largest dose being 5,000 r on each of two occasions to a lesion 25 cm.² in area.

So far only 2 instances of radium necrosis have followed the use of the present applicator. The first resulted in a rectovaginal fistula in a patient who received 4,000 r on each of two occasions over a lesion 24 cm.². She has remained free of evidence of persistent cancer since then. The second was an area of superficial necrosis in the anterior vaginal fornix in the patient with Hodgkin's disease and is probably attributable to the fact that she received simultaneous roentgen therapy since the dose with the applicator was only 3,600 r to a 5 cm.² area on the surface of the vagina.

In treating primary cancer of the vagina, doses have varied from 3,500 r to 11,300 r on the surface and from 1,600 r to 5,000 r at a depth of 0.5 cm. Four cases were treated with two applications of 3,800 r, 4,000 r, 4,200 r, and 5,000 r each. The average single dose was 4,800 r on the surface, the dose of 11,300 r being excluded from the computation. In the latter case the tumor was not controlled and the patient died eight months later. In this small series no

correlation can be made between size of dose and cure of disease. The size of the tumor, instead, seems to be the main factor since tumors of 10 cm.² or under seem to have been controlled with one exception, whereas those of larger size have continued to grow.

In cancer of the cervix with vaginal metastases, surface doses of 3,200 to 11,000 r have been given, the average being 5,700 r. The dose at 0.5 cm. depth averaged 3,100 r.

In the remaining patients, surface doses of 3,600 to 8,600 r were given. The 8,600 r was delivered to an anterior vaginal wall metastasis from a primary carcinoma of the corpus a few square centimeters in area. In this case the reaction was sharp but has healed without necrosis and the tumor metastases seems to have regressed completely.

Our experience is too limited to draw conclusions as to any relationship between dose and effect on various types of tumors. All that can be said is that surface doses up to 8,000 or 9,000 r, or possibly higher, in small lesions seem to be tolerated without producing permanent radiation necrosis.

SUMMARY

An applicator has been designed with the purpose of treating nearly all sizes and shapes of superficial vaginal lesions, and of providing adequate protection for the rest of the vagina.

A cylindrical sheath of clear lucite is first placed in the vagina and the outline of the area to be treated is determined by looking at it through the wall of the sheath with a laryngeal mirror. A lead core containing slots along the length of its surface is filled with radium tubes to cover this area. In actual treatment, the lucite sheath is accurately reinserted with the help of the head light and mirror and properly secured. The loaded lead core is then locked in place.

Tables have been constructed to show the practical arrangement of tubes necessary for uniform irradiation of rectangular lesions and the relationship between milli-

gram-hour exposure and tissue roentgens both at the surface of, and at 5 mm. depth from the vaginal wall.

Thirty cases have been treated. These include eleven primary carcinomas of the vagina, ten cancers of the cervix with vaginal extension, four carcinomas of the corpus with vaginal metastases, two carcinomas of the urethra, a case of Hodgkin's disease of the urethra, an endometrial sarcoma metastatic to the vagina, and a carcinoma of the rectum with a vaginal metastasis.

Primary carcinoma of the vagina responded well, seven of the eleven cases showing complete regression of the primary tumor. Cancer of the corpus uteri with vaginal metastases also are suitable for

treatment. Cancers of the cervix with vaginal extension have not responded very favorably, probably because of the extent of the cancer in areas other than the vagina.

Surface doses used have varied from 3,200 to 11,300 roentgens at the surface of the vagina. Doses of 8,000 to 9,000 r in small lesions seem to be tolerated without permanent radiation necrosis.

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REFERENCE

1. LEDERMAN, M., and MAYNEORD, W. V. Radium treatment of cancer of the vagina. *Brit. J. Radiol.*, 1942, 15, 307-312.



IONIZATION MEASUREMENTS WITH BONE CHAMBERS AND THEIR APPLICATION TO RADIATION THERAPY*

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THE ordinary depth dose measurements and isodose charts give information concerning the relative expected effect of irradiation on soft tissue. They do not take into consideration the bony structure which modifies the effect in two important aspects. The bones absorb more radiation than the soft tissue and therefore appreciably reduce the depth dose in the beam passing through a thick layer of bone. The bone itself is, on the other hand, exposed to more secondary electron radiation (beta rays) than the soft tissue. Particularly important is the fact that the secondary radiation varies a great deal with the wavelength of the roentgen rays.

A rather thorough study of the problems involved has been published by Juris.⁸ The investigation was supported by the Curie Radium Institute in Paris. We started our study before this publication was available and believe our data are of value both for corroboration and for extension of the knowledge in this field.

The effect of roentgen rays on tissues is due to the electron radiation (beta rays) produced and the ionization in a thimble air chamber is due mainly to the secondary electron radiation coming from the wall of the chamber. It therefore seems evident that an ionization chamber made of bone should give an indication of the effectiveness of the radiation on bone. The secondary electrons from the wall consist of Compton electrons, produced during scattering, and photo-electrons. The number of the former is independent of the wall material but the number of photo-electrons

varies with the atomic number of the elements in the wall. It increases rapidly with the atomic number for radiation of long wavelength, but only slightly for radiation of short wavelength, such as gamma rays. The path of the secondary electrons is short and amounts to about 0.1 mm. in tissue for 200 kilovolt electrons.

The following equipment was used for the measurements. A bone cylinder of 10.6 mm. inside diameter, 24 mm. length and 0.5 mm. wall thickness was made from a dry human femur, and a cap of the same material, outside diameter and thickness, was attached to one end. The other end slipped over a polystyrene insulating rod to an extent of 6 mm. so that an ionization chamber was formed with a volume of 1.6 cc. The inside electrode consisted of a 0.8 mm. diameter aluminum wire. The other part of the attachment was made similar to the removable Victoreen ionization chamber with nearly the same capacity. The bone ionization chamber thus could be used interchangeably with the ordinary "air wall" chamber in a Victoreen roentgenmeter which was used for the measurements.

One bone cylinder with a wall thickness of 2 mm. was made to fit over the ionization chamber and a second one with a wall thickness of 2.3 mm. could be slipped over the first one. Measurements could thus be taken with chambers of 0.5, 2.5 and 4.8 mm. thick bone.

A chamber similar in size and shape was made of lucite with a wall thickness of 0.5 mm. Measurements with this chamber gave

* From the Department of Radiology and Physical Therapy of the University of Minnesota and The University Hospitals, Minneapolis, Minn. Aided by the research funds of the Graduate School of the University of Minnesota. Read at the annual meeting of the Minnesota Radiological Society, May 26, 1945.

TABLE I

COPPER (CU) FILTER ALWAYS FOLLOWED BY 1 MM. ALUMINUM (AL)
 TIN (SN) FILTER ALWAYS FOLLOWED BY 0.25 MM. CU AND 1 MM. AL

100 kv. (peak)		140 kv. (peak)		220 kv. (peak)		400 kv. (peak)	
Filter	Half-Value Layer	Filter	Half-Value Layer	Filter	Half-Value Layer	Filter	Half-Value Layer
(mm.)	(mm. Cu)	(mm.)	(mm. Cu)	(mm.)	(mm. Cu)	(mm.)	(mm. Cu)
0	0.05	0	0.09	0	0.42	0	1.42
1.0 Al	0.09	1.0 Al	0.12	0.125 Cu	0.70	0.5 Cu	2.3
0.125 Cu	0.15	2.0 Al	0.17	0.25 Cu	0.97	1.0 Cu	3.2
0.25 Cu	0.25	0.125 Cu	0.27	0.5 Cu	1.34	2.0 Cu (or	
0.5 Cu	0.35	0.25 Cu	0.42	0.75 Cu	1.63	0.44 Sn)	3.8
0.75 Cu	0.42	0.5 Cu	0.58	1.0 Cu	1.90	3.0 Cu	4.2
1.0 Cu	0.47	0.75 Cu	0.69	1.25 Cu	2.12	4.0 Cu (or	
1.25 Cu	0.52	1.0 Cu	0.77	1.5 Cu	2.21	0.88 Sn)	4.4
1.5 Cu	0.55	1.25 Cu	0.86	2.0 Cu	2.44	5.0 Cu	4.7
2.0 Cu	0.60	1.5 Cu	0.93	3.0 Cu	2.65	6.0 Cu (or	
		2.0 Cu	1.05	4.0 Cu	2.8	1.32 Sn)	4.8
		2.5 Cu	1.15	4.75 Cu	2.9	8.0 Cu	4.9
						10.0 Cu	4.9
						12.0 Cu	5.0
						1.32 Sn+	
						15.5 Cu	5.2

results which were directly proportional to the Victoreen chamber within 1 per cent over the whole range of roentgen rays used when the 0.8 mm. diameter aluminum electrode was used.

Another bone chamber with 1.1 mm. wall thickness was used for some of the measurements. The measurements with this chamber did not deviate more than 5 per cent from the 0.5 mm. bone chamber.

It should be noted that the small surface of the bone ionization chamber through which the aluminum electrode enters, consists of polystyrene instead of bone. Some measurements were, however, taken with a bone cap covering this surface but as the values did not then change more than 10 per cent this precaution seemed unnecessary. Errors due to the fact that the inside electrode consisted of aluminum rather than bone and to the rather large size of the chamber should be of the same order of magnitude. Such errors, perhaps amounting to 10 per cent, would be of little importance and would not change the conclusions obtained.

Juris found the dry bone was a satisfactory conductor for the wall of the chamber and that it was unnecessary to coat the inside of the conducting surface. This is very fortunate as even a very thin layer of

TABLE II

EQUIVALENT WAVE LENGTH SCALE

Half-Value Layer	Wave-length Å	Half-Value Layer	Wave-length Å
mm. Cu		mm. Cu	
0.05	0.45	0.500	0.20
0.082	0.40	1.065	0.15
0.15	0.35	2.32	0.10
0.198	0.30	3.18	0.075
0.282	0.25	4.0	0.063

graphite stops a high percentage of the secondary electrons, as will be shown in a curve plotted from measurements with a graphite lined bone chamber. The coating could not be applied with uniform thickness but it could be determined that it was less than 0.1 mm.

Juris also used fresh undried bone and found that the ionization in such a chamber differed very little from one made of dry bone.

Measurements were first taken in air and later at different depths in a specially constructed water phantom.⁹

Table I gives the peak voltages and the filters used and the corresponding half-value layers in copper as determined by absorption curves. Table II shows the half-value layer for certain wavelengths of homogeneous radiation.⁷

In order to obtain information about the amount of radiation absorbed by bone, measurements were taken with both the

TABLE IV

FREE AIR MEASUREMENT—BONE IONIZATION
CHAMBER (0.5 MM. WALL)

100 kv. (peak)		140 kv. (peak)	
Half-Value Layer	% Bone / Lucite	Half-Value Layer	% Bone / Lucite
mm. Cu		mm. Cu	
0.05	263	0.09	285
0.09	318	0.12	330
0.15	385	0.27	373
0.25	408	0.42	374
0.35	406	0.58	355
0.42	395	0.69	333
0.47	386	0.77	310
0.52	380	0.86	297
0.55	366	0.93	288
0.60	352	1.05	267
220 kv. (peak)		400 kv. (peak)	
0.42	307	1.42	238
0.70	297	2.3	192
0.97	283	3.2	168
1.34	256	3.8	147
1.63	238	4.2	138
1.90	226	4.4	134
2.12	213	4.7	129
2.21	201	4.8	128
2.44	188	4.9	124
2.65	168	4.9	122
2.8	159	5.0	121
2.9	153	5.2	115

TABLE IIIa

4.3 MM. BONE ADDED TO BONE OR
AIR WALL CHAMBERS

100 kv. (peak)		140 kv. (peak)	
Half-Value Layer	Per Cent	Half-Value Layer	Per Cent
mm. Cu		mm. Cu	
0.05	33.0	0.09	42
0.09	42.0	0.12	51
0.25	73.0	0.42	82
0.35	80.0	0.69	87
0.42	85.5	1.15	91
220 kv. (peak)		400 kv. (peak)	
0.42	76.5	1.4	87
0.70	81.0	3.8	95
0.97	86.5		
1.34	89.5		
1.63	94.0		
2.44	95.0		

TABLE IIIb

TRANSMISSION 4.3 MM. BONE

Half-Value Layer	Per Cent	Half-Value Layer	Per Cent
mm. Cu		mm. Cu	
3.93	96.3	0.694	90.0
3.35	95.7	0.502	87.1
2.39	95.3	0.389	84.8
1.84	94.6	0.246	78.8
1.41	93.4	0.068	43.3
1.14	92.5	0.042	27.0

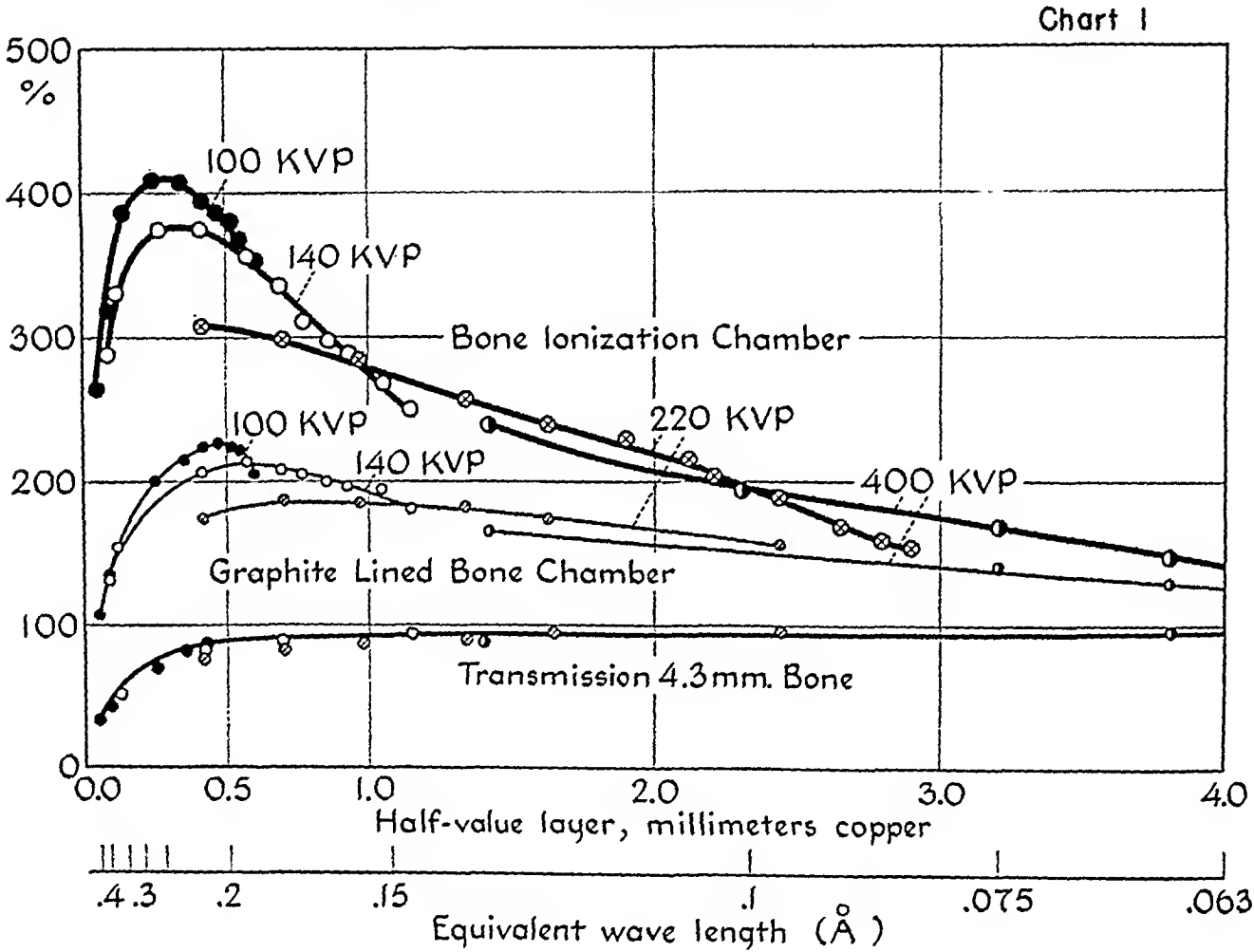
bone chamber and the lucite chamber, first uncovered and then with the two bone cylinders over the chambers. The values obtained with one of the chambers covered with bone, divided by the values measured with the uncovered chamber gives the per cent transmission through 4.3 mm. bone. The same transmission figures were found with both chambers and are given for the different half value layers in Table IIIa. They are also plotted in the lower portion of Charts I and II. The points fall close to the curve which represents values calculated from data on bone absorption^{1,7} for different wavelengths of homogeneous rays (Table IIIb). It is important to note that in therapy as much as two-thirds of the rays are absorbed by 0.5 cm. bone when 100 kv. (peak) unfiltered radiation is used. With 140 kv. (peak) and 0.25 mm. copper filter

about 20 per cent is absorbed by 0.5 cm. bone and the absorption is as high as 5 per cent even when 400 kv. (peak) and 2 mm. copper filter is used.

Of importance for the measurements with the bone chamber is the fact that 0.5 mm. absorbs a high percentage of the soft radiation and it amounts to more than 25 per cent for half-value layer 0.05 mm. copper.

clearly in Chart I where the obtained figures are plotted against the half-value layers. The homogeneous wavelengths of the corresponding half-value layers are marked on a second scale. The curve for 100 kv. (peak) shows a maximum at a half-value layer of 0.3 mm. copper of over 400 per cent. The ionization in bone thus can be expected to be more than four times as great as in soft

Free Air Measurement



In order to obtain a clear picture of the intense ionization produced in bone, the readings of the r-meter obtained with the bone ionization chamber are expressed in percentage of the readings obtained with the lucite chamber. These are the figures which will be found in the following tables and charts.

Table iv gives the figures obtained for different voltages and different half-value layers when the uncoated 0.5 mm. wall bone chamber was used in air. The trend is shown

tissue for this type of radiation. The maximum can be expected to be even higher if a thinner wall is used, as 0.5 mm. bone absorbs a considerable amount of the radiation. The decline of the curve with softer radiation is undoubtedly due to the increased absorption and no maximum point would be expected if correction for absorption were applied. As mentioned before, more than 25 per cent correction should be applied for half-value layer 0.05 mm. copper.

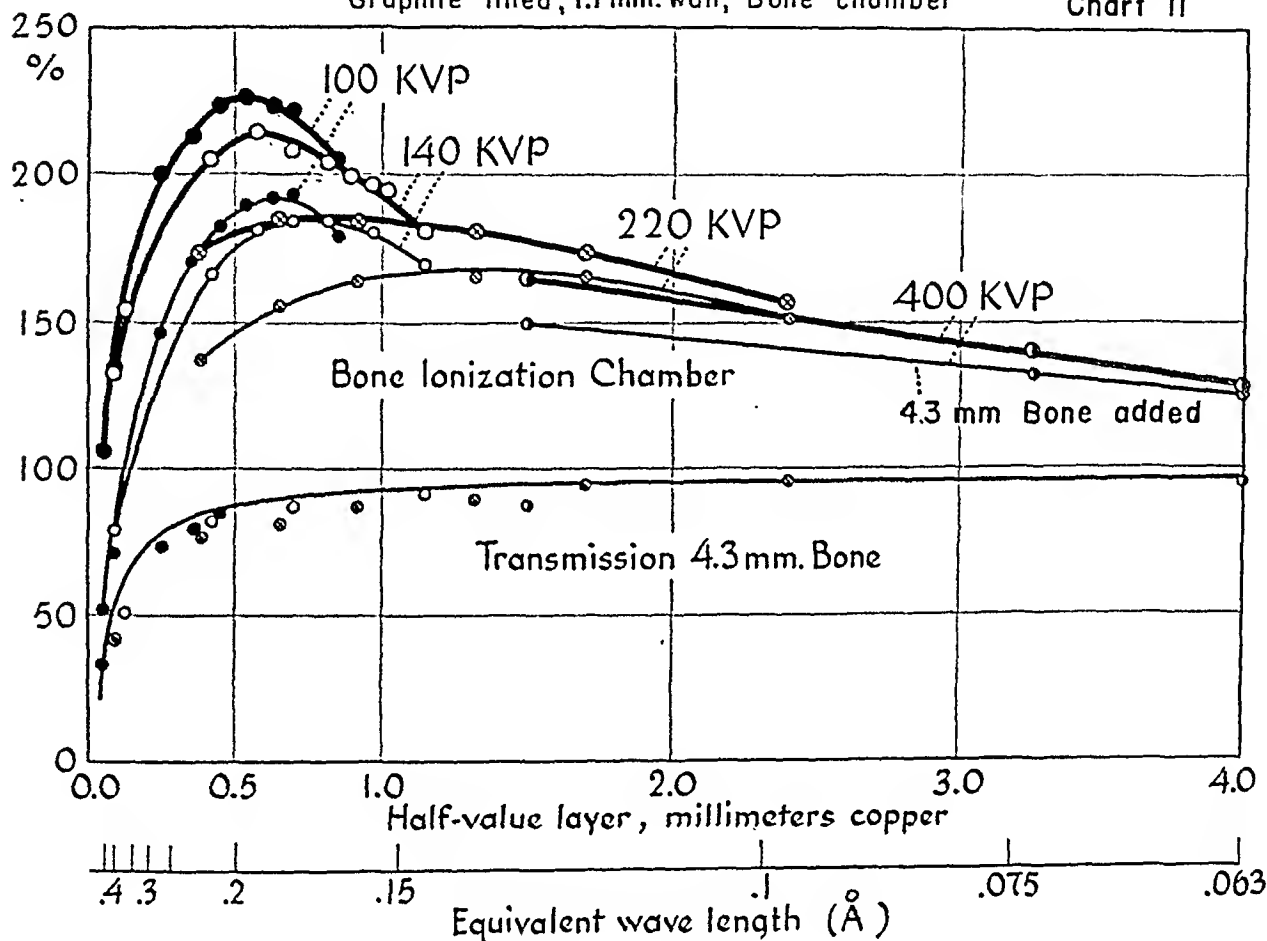
The graph shows, as was to be expected, that the ionization in the bone chamber gradually declines towards the values for the "air wall" chamber with increasing half-value layer and reaches a value of 147 per cent for half-value layer 3.8 mm. copper (400 kv. (peak) and 2 mm. copper filter). Through the courtesy of Dr. Edward Schons of St. Paul, a few measurements

even and its thickness could therefore not be determined, though it can be stated that it did not exceed 0.1 mm. at any place. The values of these measurements shown in Table v and plotted in Chart II, indicate to what extent the secondary beta rays are absorbed by this layer of graphite. (Compare with Table iv and Chart I.) The ionization contributed by the beta rays

Free Air Measurement

Graphite lined, 1.1 mm. wall, Bone chamber

Chart II



were taken with his 1,000 kilovolt machine, with a half-value layer of 9.5 mm. copper (filter: 1 mm. lead + 0.5 mm. copper). A value of 108 per cent was obtained. Measurement with gamma rays from radium filtered with 0.5 mm. platinum gave a result of 104 per cent. This is identical with that given by Smereker.¹¹

One of the bone chambers with a wall-thickness of 1.1 mm. had the inside surface coated with a thin layer of graphite. Unfortunately the coating was somewhat un-

from the bone has been reduced to about one-half by this thin layer of graphite.

The size of the ionization chamber may conceivably influence the result as some of the secondary beta rays will not reach the center of the ionization chamber. A smaller bone chamber may therefore give higher values. In order to obtain some information regarding this factor, bone and lucite chambers were made with about half the diameter of the original chambers (5.5 mm. as compared to 10.6 mm.). The curves in

TABLE V
FREE AIR MEASUREMENT—GRAPHITE LINED (INSIDE)
BONE CHAMBER (1.1 MM. WALL)

100 kv. (peak)		140 kv. (peak)	
Half-Value Layer	%Bone /Lucite	Half-Value Layer	%Bone /Lucite
mm. Cu		mm. Cu	
0.05	106	0.09	132
0.09	134	0.12	154
0.25	200	0.42	205
0.35	213	0.58	214
0.42	223	0.69	208
0.47	226	0.77	204
0.52	223	0.86	199
0.55	221	0.93	196
0.60	204	1.05	194
		1.15	108

220 kv. (peak)		400 kv. (peak)	
0.42	173	1.42	164
0.70	185	3.2	140
0.97	184	3.8	128
1.34	181		
1.63	173		
2.44	156		

tered radiation with a half-value layer greater than 0.5 mm. copper (equivalent wavelength of 0.2 Å). For 220 kv. (peak) radiation, with inherent filtration only (0.2 mm. copper), a 4.4 per cent increase is obtained with the small chamber. The main difference is found for very soft radiation and the increase for the small chamber amounts to 23 per cent for 100 kv. (peak) unfiltered radiation with a half-value layer of 0.05 mm. copper.

The measurements with the small chamber thus indicate that the trend of increased secondary bone radiation towards lower half-value layers is even more pronounced than shown in Chart 1. The difference is, however, of secondary importance and does not affect the main conclusions. The maximum value for the ionization in bone is about 500 per cent.

It is well known that the absorption and scattering of tissues will change the spectral composition of the rays so that the half-value layer increases for very soft rays and decreases for hard rays with increasing depth. Measurements were therefore taken at different depths in the water phantom for the different types of radiation which

Chart v shows the results with the two sizes of chambers. It can be seen that no appreciable difference occurs for well fil-

Bone Ionization Chamber In Water Phantom
Field 20X20cm 0.5mm Bone

Chart III

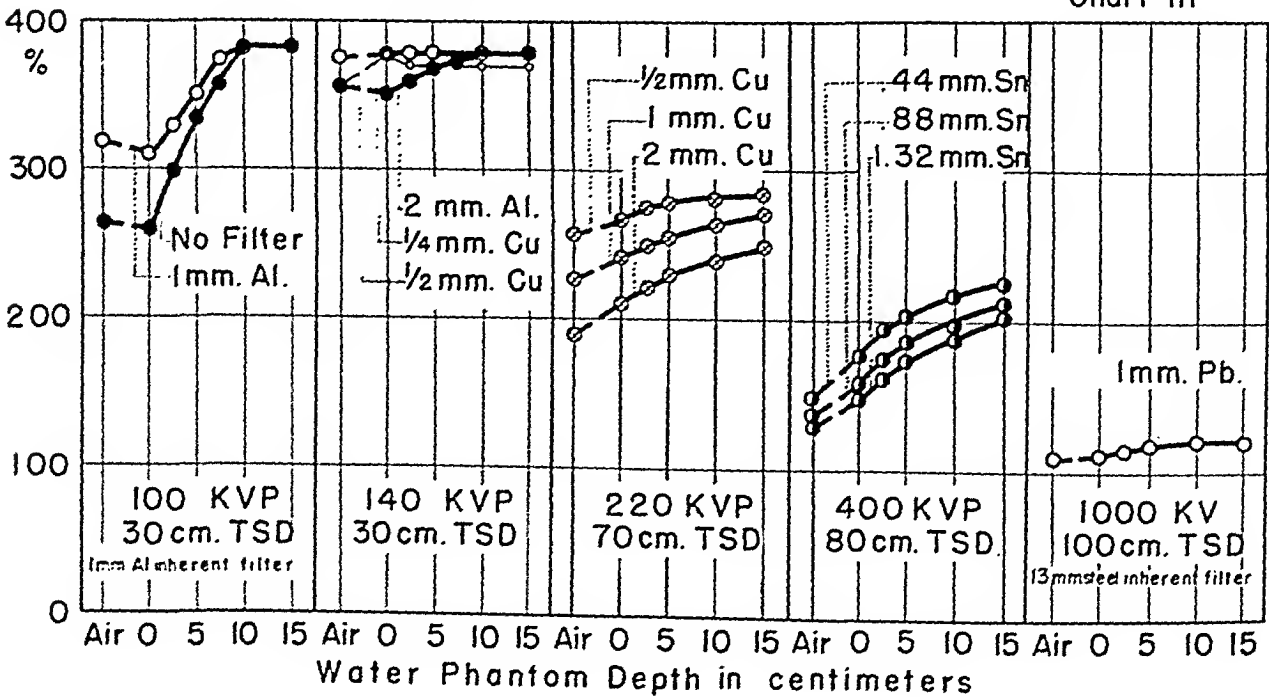


TABLE VI

BONE IONIZATION CHAMBER IN WATER PHANTOM—FIELD 20×20 CM. %BONE/LUCITE

Depth	100 kv. (peak)	30 cm. target skin distance	Depth	140 kv. (peak)	30 cm. target skin distance
cm.	(1 mm. Al inherent filter) No filter	1 mm. Al	cm.	2 mm. Al	$\left\{ \begin{array}{l} 0.25 \text{ mm. Cu} \\ +1 \text{ mm. Al} \end{array} \right.$ $\left\{ \begin{array}{l} 0.5 \text{ mm. Cu} \\ +1 \text{ mm. Al} \end{array} \right.$
Air	263	318	Air	355	374
Surface	260	310	Surface	350	377
2.5	298	329	2.5	358	378
5.0	333	350	5.0	369	378
7.5	356	373	7.5	371	378
10.0	382	382	10.0	378	378
15.0	382	382	15.0	378	378

Depth	220 kv. (peak)	70 cm. target skin distance
cm.	$\left\{ \begin{array}{l} 0.5 \text{ mm. Cu} \\ +1 \text{ mm. Al} \end{array} \right.$	$\left\{ \begin{array}{l} 1 \text{ mm. Cu} \\ +1 \text{ mm. Al} \end{array} \right.$ $\left\{ \begin{array}{l} 2 \text{ mm. Cu} \\ +1 \text{ mm. Al} \\ \text{or } 0.44 \text{ Sn} \end{array} \right.$
Air	256	226
Surface	265	240
2.5	273	248
5.0	277	253
10.0	280	263
15.0	283	270

Depth	400 kv. (peak)	80 cm. target skin distance	Depth	1000 kv.	100 cm. target skin distance
cm.	$\left\{ \begin{array}{l} 0.44 \text{ mm. Sn} \\ +0.25 \text{ mm. Cu} \\ +1 \text{ mm. Al} \end{array} \right.$	$\left\{ \begin{array}{l} 0.88 \text{ mm. Sn} \\ 0.25 \text{ mm. Cu} \\ +1 \text{ mm. Al} \end{array} \right.$	cm.	(13 mm. steel inherent filter) (1 mm. Pb + 0.5 mm. Cu)	
Air	147	134	Air		108
Surface	174	156	Surface		109
2.5	192	173	2.5		113
5.0	201	185	5.0		116
10.0	216	196	10.0		118
15.0	225	210	15.0		118

are commonly used in therapy. The values with the uncoated bone chamber again expressed in percentage of those obtained with the lucite chamber are presented in Table VI and Chart III. Several interesting observations can be made. The radiation produced with 100 kv. (peak) and used either unfiltered or filtered with 1 mm. aluminum is gradually hardened until a depth of 10 cm. is reached. The measured values increase up to this depth as rays which do not penetrate the 0.5 mm. bone wall are filtered out by the tissues. A somewhat similar, though less pronounced,

effect is observed for the 140 kv. (peak) radiation filtered with 2 mm. aluminum. When the rays are filtered with 0.25 or 0.5 mm. copper very little change in the hardness can be noted and the values remain at about 380 per cent; 220 kv. (peak) radiation filtered with 0.5, 1 or 2 mm. copper is softened to a certain extent but the highest values obtained at 15 cm. depth still remain below 283 per cent. The effect is more marked for the rays produced with 400 kv. (peak) and the values increase from 145 per cent at the surface to 200 per cent at 15 cm. depth when 1.32 mm. tin + 0.25 mm. copper

filter is used. Even so the values remain below the 210 per cent at the surface for the 220 kv. (peak) radiation filtered with 2 mm. copper. Radiation produced with 1,000 kv. and filtered with 1 mm. lead and 0.5 mm. copper is not changed enough by the tissues to increase the bone ionization very much. From a value of 109 per cent at the surface it increases to 118 per cent at 15 cm. depth.

and 0.88 mm. tin.+0.25 mm. copper for 400 kv. (peak).

The main value of such measurements as here presented is their application to therapy. The damage to bone in the path of the beam during treatment ought to be proportional to the ionization produced in the bone. "Tissue dose" at any depth (or "depth dose") is ordinarily expressed in percentage of the skin dose. The ionization

TABLE VII
HALF-VALUE LAYERS OF THE RADIATION AT DIFFERENT DEPTHS IN A WATER PHANTOM; MM. COPPER

Depth	100 kv. (peak)	100 kv. (peak)	140 kv. (peak)	140 kv. (peak)	140 kv. (peak)
cm.	No filter	1 mm. Al	2 mm. Al	0.25 mm. Al	0.5 Cu
Air	0.05	0.09	0.17	0.42	0.58
0	0.05	0.09	0.15	0.38	0.4
2.5	0.08	0.10	0.18	0.35	0.5
5.0	0.10	0.12	0.24	0.35	0.5
7.5	0.13	0.14	0.26	0.35	0.5
10.0	0.15	0.15	0.35	0.35	0.5
15.0	0.15	0.15	0.35	0.35	0.5

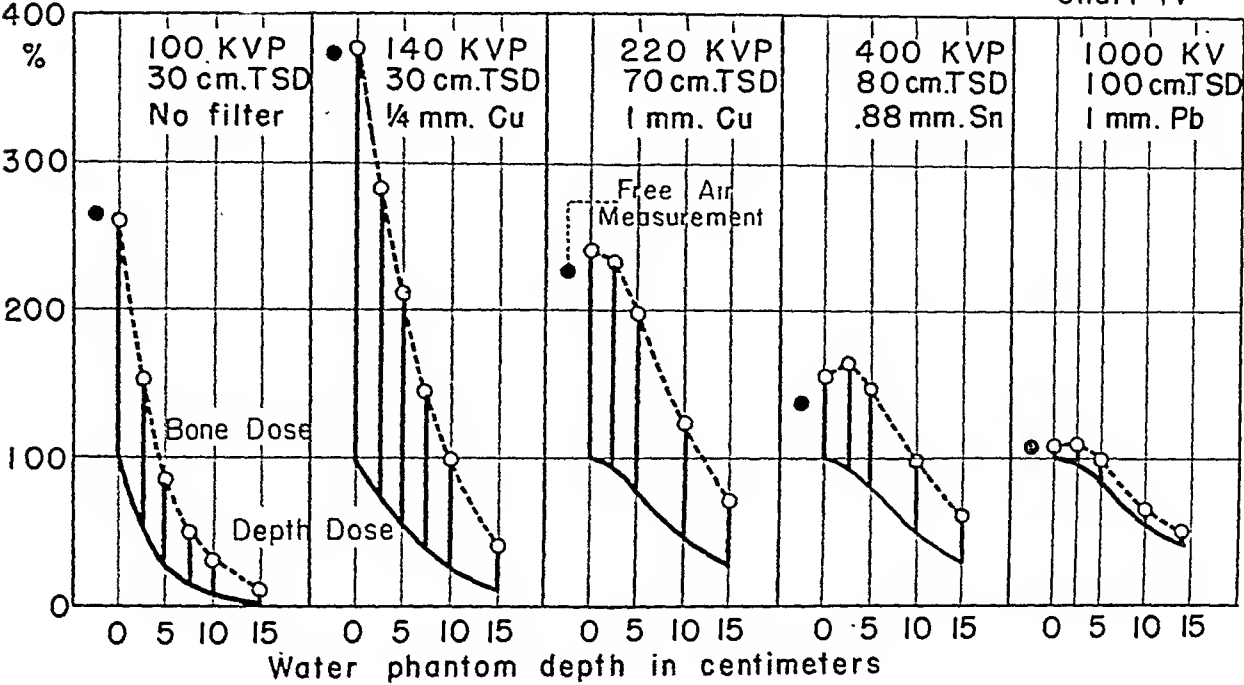
Depth	220 kv. (peak)	220 kv. (peak)	220 kv. (peak)	400 kv. (peak)	400 kv. (peak)	400 kv. (peak)
cm.	0.5 mm. Cu	1 mm. Cu	2 mm. Cu (or .44 mm. Sn)	0.44 mm. Sn	0.88 mm. Sn	1.32 mm. Sn
Air	1.34	1.90	2.44	3.8	4.4	4.8
0	1.2	1.6	2.1	3.0	3.45	3.9
2.5	1.1	1.5	2.0	2.3	3.0	3.4
5.0	1.0	1.4	1.9	2.15	2.6	3.1
10.0	0.95	1.2	1.6	1.9	2.2	2.5
15.0	0.9	1.1	1.5	1.7	2.0	2.2

These measurements give us some information about the extent to which the rays are softened at different depths in tissues. If it is assumed that rays with the same half-value layer contribute the same amount of secondary beta radiation from bone, then the half-value layer and equivalent wavelength for the radiation at different depths can be found from the obtained figures as shown in Table VII and Chart VI. This is not a very accurate method as pointed out by Clarkson and Mayneord³ but it gives an approximation. It would seem from the figures obtained that a filter of 0.44 mm. tin+0.25 mm. copper (Thoraues) may be advisable for 220 kv. (peak)

in bone may be expressed likewise in percentage of the skin dose. These figures on "bone dose" in percentage surface (or skin) dose, found in Table VIII and Chart IV, are obtained by multiplying the figures of Table VI by the corresponding percentage depth dose (Table VIII). For the same surface dose the bone dose is greatest when 140 kv. (peak) radiation filtered with 0.25 mm. copper (or a few mm. aluminum) is used, at least up to a depth of 5 cm. The 400 kv. (peak) filtered radiation supplies a smaller bone dose at depths less than 10 cm. As a general rule it can be stated that the harder the rays, the less damaging they are to bone if exception is made for the very soft rays

Depth Dose and Bone Dose in Percent of Surface Dose

Chart IV



Free Air Measurement
Dependence on Diameter of Chamber

Chart V

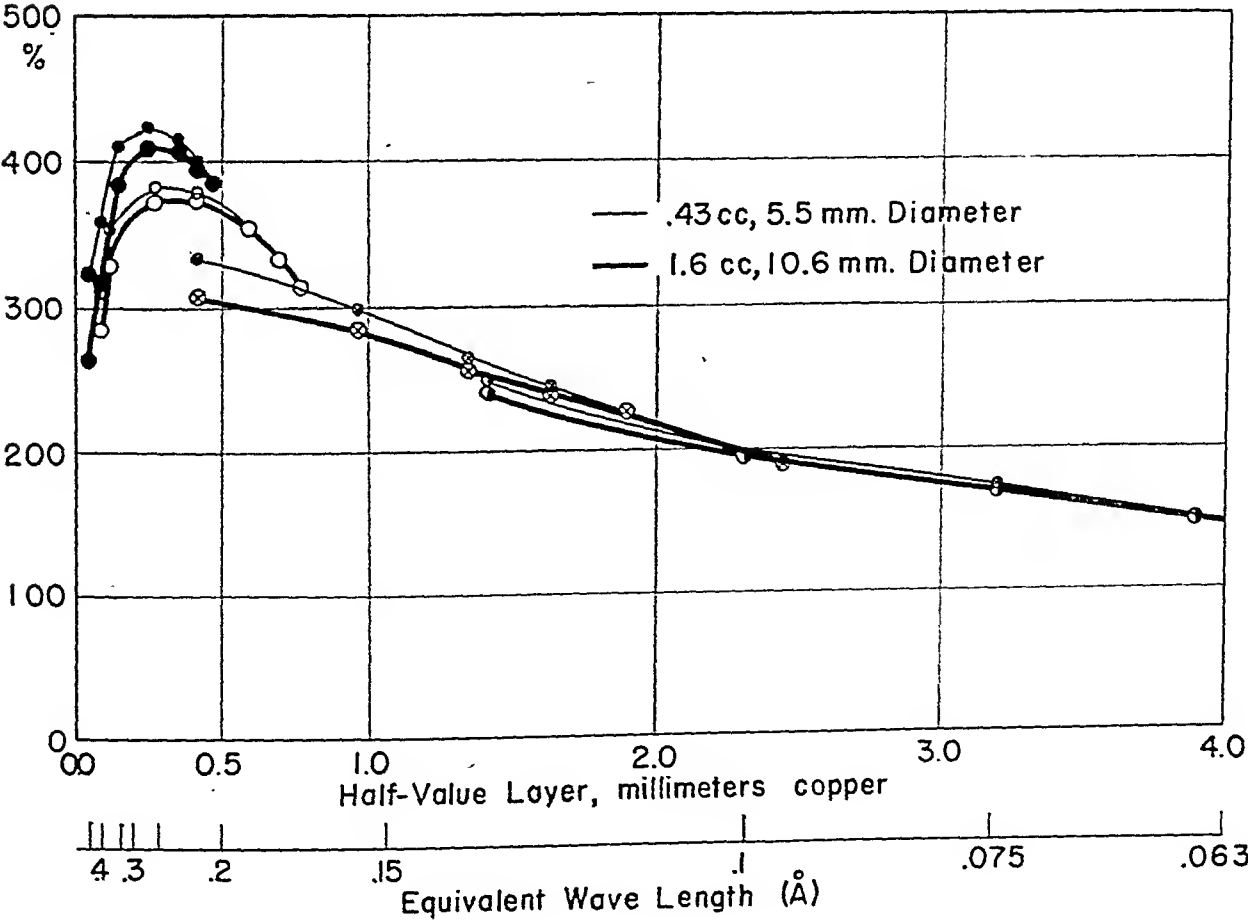


TABLE VIII

DEPTH DOSE (AIR WALL CHAMBER) AND BONE DOSE IN PERCENTAGE OF SURFACE DOSE

100 kv. (peak)			140 kv. (peak)		
30 cm. target distance			30 cm. target distance		
Depth	No Filter % Depth Dose	Half-value layer 1.7 mm. Al % Bone Dose	Depth	0.25 mm. Cu Filter % Depth Dose	Half-value layer 0.42 mm. Cu % Bone Dose
Air		263	Air		374
Surface	100	260	Surface	100	377
2.5 cm.	51.5	153	2.5 cm.	75.5	282
5.0 cm.	25.4	84.5	5.0 cm.	55.2	211
7.5 cm.	14.1	50.2	7.5 cm.	38.5	145
10.0 cm.	8.1	30.9	10.0 cm.	26.4	99
15.0 cm.	2.7	10.5	15.0 cm.	10.8	41.4

220 kv. (peak)			400 kv. (peak)		
70 cm. target skin distance			80 cm. target skin distance		
Depth	1 mm. Cu Filter % Depth Dose	Half-Value layer 1.9 mm. Cu % Bone Dose	Depth	.88 mm. Sn Filter % Depth Dose	Half-Value layer 4.4 mm. Cu % Bone Dose
Air		226	Air		134
Surface	100	240	Surface	100	156
2.5 cm.	94.0	232	2.5 cm.	95.0	164
5.0 cm.	78.5	198	5.0 cm.	80.0	148
10.0 cm.	47.0	124	10.0 cm.	50.5	99
15.0 cm.	26.5	72	15.0 cm.	30.0	63

1000 kv.		
1 mm. Pb Filter		
Depth	% Depth Dose	100 cm. target skin distance Half-value layer 9.5 mm. Cu % Bone Dose
Air		108
Surface	100	109
2.5 cm.	97	110
5.0 cm.	86	100
10.0 cm.	55	65
14.0 cm.	43	51

which would have an intense effect only on the superficial layer of a bone at or very close to the surface.

The opposite rule applies, however, to the bone marrow as the secondary beta rays travel a very short distance, particularly for low voltages (few penetrate more than 0.01 mm.). The cortex reduces the intensity

proportionately less the harder the rays.

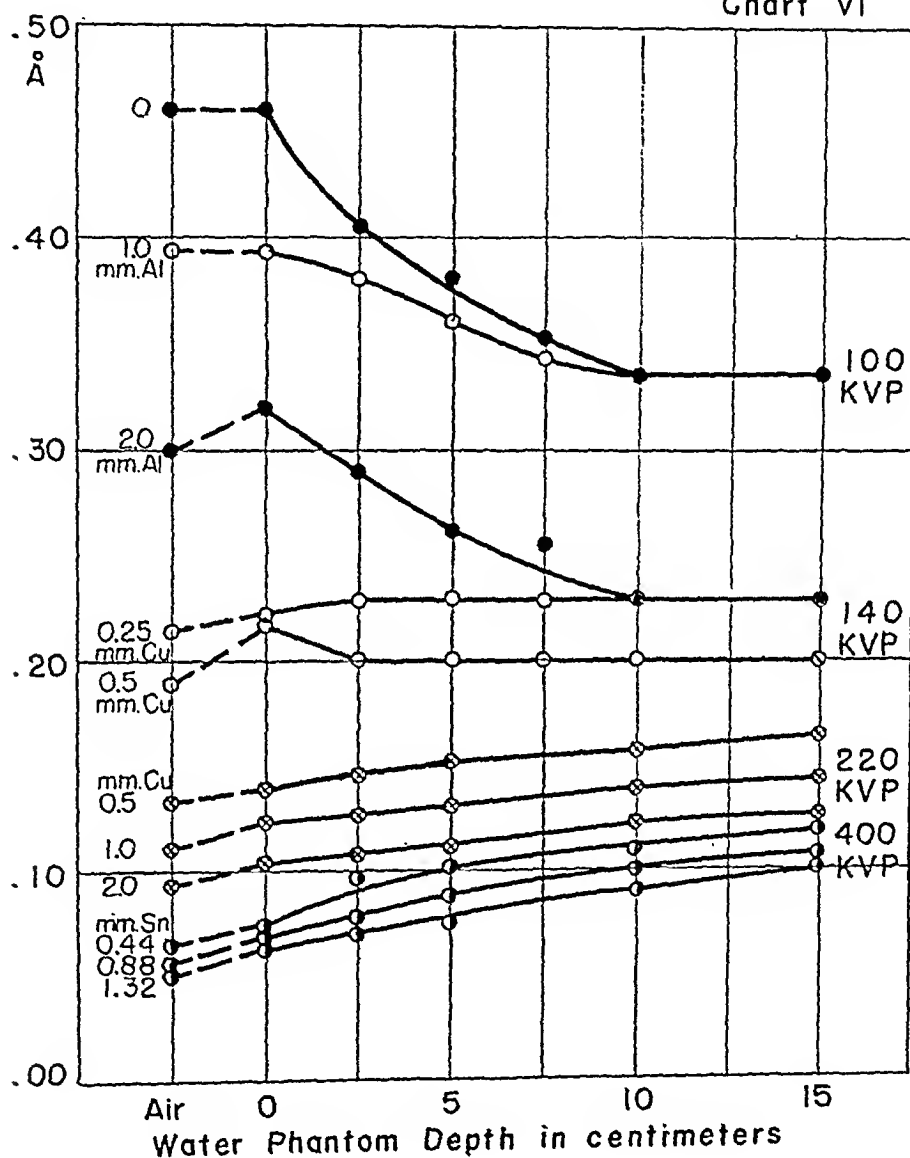
Camp² reported recently on late bone necrosis occurring many years after roentgen therapy in a few patients who had been treated for pituitary tumors. These patients had been treated at a time (around 1920) when 140 kv. (peak) was the maximum voltage available. It is interesting to note

that the radiation used is the worst possible, as it supplies an extremely high bone dose near the surface where the temporal bone is located. Slaughter¹⁰ has reported the most

somewhat harder but still in a range which supplies a high bone dose. Perhaps some damage of this type may be avoided with the use of rays of greater half-value layer.

"Quality" of Radiation in Phantom

Chart VI



severe after effects (of 5 cases of fracture of the clavicle) in one case following the lowest "tissue dose" to the clavicle. It was noted that this case was treated with 140 kv. (peak) radiation, while the other cases reported were treated with 200 or 250 kv. or with radon. A number of reports are also found in the literature concerning fractures following irradiation of different bones (head of femur, ribs, clavicle).^{4,6} The rays responsible for these results were as a rule

SUMMARY AND CONCLUSIONS

Measurements have been made with ionization chambers constructed of bone in order to obtain some information on the total ionization in bone in connection with roentgen therapy. All ionization figures are expressed in percentage of bone chamber to "air wall" chamber of identical volume and capacity.

Maximum values of over 400 per cent (bone compared to lucite) were observed

for 100 kilovolts (peak) with a half-value layer of 0.3 mm. copper, and of about 380 per cent for 140 kv. (peak) with a half-value layer of 0.35 mm. copper. Values were lower for higher voltages and greater filtration.

Measurements taken with a water phantom indicated a greater amount of ionization in bone (up to 5 cm. depth in the phantom) when 140 kv. (peak) was used, than was observed at any other voltage. This may have direct application in therapy as 140 kv. (peak) may be preferred when ionization in bone is desirable, and used with caution when bone damage is to be avoided.

Figures are presented which show the change in the "quality" of the radiation as it penetrates the phantom. Radiation generated by the lower voltages is "hardened," and that generated by 220-400 kv. is "softened." One thousand kilovolt radiation is not altered appreciably in "quality" by the phantom.

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REFERENCES

1. ARMSTRONG, W. D. Composition of cortex of dry human tibia 24.7 per cent Ca, 10.7 per cent P.

Personal communication.

2. CAMP, J. D. Radiation necrosis of calvarium. *Radiology*, 1945, 45, 213-219.
3. CLARKSON, J. R., and MAYNEORD, W. V. "Quality" of high-voltage radiations; "quality" within scattering medium. *Brit. J. Radiol.*, 1939, 12, 168-180.
4. DALBY, R. G., JACOX, H. W., and MILLER, N. F. Fracture of the femoral neck following irradiation. *Am. J. Obst. & Gynec.*, 1936, 32, 50-59.
5. GALL, E. A., LINGLEY, J. R., and HILCKEN, J. A. Comparative experimental studies of 200 kilovolt and 1000 kilovolt roentgen rays; biological effects on the epiphysis of the albino rat. *Am. J. Path.*, 1940, 16, 605-618.
6. GRATZEK, F. R., HOLMSTROM, E. G., and RIGLER, L. G. Post-irradiation bone changes. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 53, 62-76.
7. ALLEN, S. J. M. Mass absorption coefficients (compilation). Handbook of Chemistry and Physics. Twenty-second edition.
8. JURIS, K. Vergleichende Untersuchungen der Röntgenstrahlung einer 500 KV Apparatur und einer 200 KV Apparatur. *Radiol. Clin.*, 1941, 10, 205.
9. MARVIN, J. F. A simple portable water phantom. *AM. J. ROENTGENOL. & RAD. THERAPY*, Dec., 1946, 56, 785-786.
10. SLAUGHTER, D. P. Radiation osteitis and fractures following irradiation. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1942, 48, 201-212.
11. SMEREKER, HILDA. Beiträge zu Fragen der Radiumdosimetrie. *Strahlentherapie*, 1939, 64, 492-511.



ABSORPTION MEASUREMENTS FOR BROAD BEAMS OF 1 AND 2 MEGAVOLT ROENTGEN RAYS*

By G. SINGER, C. B. BRAESTRUP†, and H. O. WYCKOFF

I. INTRODUCTION

ROENTGEN-RAY protection data are generally based on absorption coefficients determined for roentgen-ray beams of small cross section. Such coefficients can be accurately determined under laboratory conditions. Outside of the laboratory such narrowly collimated beams are not common. Therefore, it is to be expected that absorption data for collimated beams will not be directly applicable in designing protective barriers under conditions such that attenuation by the barrier is to an appreciable extent by scattering rather than by true absorption. These conditions obtain when the barrier material is of low atomic number and when the radiation is penetrating. For a heavy barrier material—such as lead—and for less penetrating radiation, attenuation is largely by true absorption. Only under these conditions may the absorption data obtained for collimated beams be safely applied to barrier design.

Concrete, being structurally self-supporting, relatively inexpensive, and easily fabricated, has become the standard material for the construction of barriers for protection against very penetrating radiation. Theoretical absorption curves applicable to such barriers are not currently available for wide-angle beams. In the calculations for such absorption curves a correction must be made for scattering which retains the scattered photons within the confines of the primary beam, a process tending to reduce the attenuation for wide-angle beams in comparison with that for narrow beams of the same radiation. This problem has been recognized in several papers relating to roentgen-ray protection.^{1,2,3,4} However, because of the considerable technical difficulties involved in

obtaining such data experimentally, all discussion in the literature relating to the increase in barrier thickness needed for wide-angle beams over that for narrow beams is of a general and indirect nature and not sufficiently detailed for specific application in the development of protection specifications.

In the design of protective barriers, information is also needed on the variation of roentgen-ray dosage rate with distance from the protective barrier to the position at which personnel will be stationed. Because of scattering from the wall it is to be expected that for very penetrating radiation this variation will not follow the inverse square law for the distance measured from the tube target. It is to be expected that this variation will be more rapid than indicated by this law because both the roentgen tube target and the irradiated volume of concrete act as sources of radiation.

It is the purpose of this paper to present (1) experimental data on absorption of roentgen rays in concrete for wide-angle beams generated by voltages of 1 and 2 megavolts, (2) preliminary data on the variation of the dosage rate with the distance from a protective barrier, and (3) data on concrete protection requirements for 1 and 2 mv. radiation under certain conditions which obtain in practice.

II. METHOD

The experimental arrangement used in obtaining the basic data given below is indicated in Figure 1. The concrete wall *C* is the main wall of the building housing the generator and is 41 inches* thick; *D* is the covered maze within which the ionization measurements were made.

* Because the thickness of protective barriers is often of practical interest to persons unfamiliar with metric units, we have specified the dimensions of all barriers in feet and inches.

* From the National Bureau of Standards, Washington, D. C.

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Dosage measurements were made by calibrated dosage instruments designed by Braestrup.⁵ Three sizes of ionization chambers were used; their characteristics are listed in Table I. The ionization chamber potentials were measured before and after irradiation by means of a string electrometer which is an integral part of the dosage

radiation and were found to be in agreement therewith to within 2 per cent. The barrier material consisted of solid concrete blocks of density 130 lb. per cu. ft. measuring $5\frac{3}{4}$ by $7\frac{3}{4}$ by $23\frac{3}{4}$ inches. These were laid without mortar in the doorway *A* shown in Figure 1. Measurements were made through sets of double layers of these blocks; one $5\frac{3}{4}$ in. thick and the other $7\frac{3}{4}$ in. The layers were staggered so that the planes of the cracks between blocks did not pass through either the tube target or ionization chamber. The opening remaining between the top of the test barrier and the lintel of the doorway to the maze was filled with lead bricks. For this arrangement both the radiation leakage through the doorway *B*—produced by the rays scattered through a glass-brick window above the main wall *C*—and that through cracks in the test barrier itself were found to be negligible in comparison with the dosage rate at the position of the test ionization chambers.

The distance *E* of Figure 1 was 1.83 meters in all cases; *F* is the barrier thickness. This thickness was converted to thickness of concrete of a density of 147 lb. per cu. ft. before plotting. The wall-to-center-of-chamber distance *G* varied from 2 to 4 inches for all plotted points. The ionization chambers were placed as near as practicable to the radiation barrier. It will be shown later that this position gives the minimum apparent absorption. The roentgen-ray generator used is the 2 mv. roentgen-ray resonance generator described by Charlton and Westendorp⁶

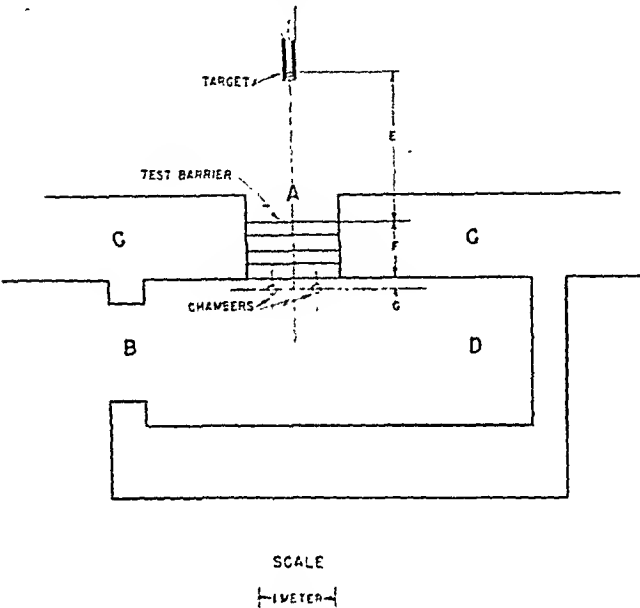


FIG. 1. Experimental arrangement showing two sets of concrete test blocks in place. A total of three such sets were used.

meter. All ionization chambers were calibrated with both 175 kv. roentgen rays and gamma rays from radium. Both calibrations agreed very well with the theoretical values based upon the air volume and capacitance. At the National Bureau of Standards the small thimble chamber and the electrometer head were checked against a similar instrument combination with 1 mv.

TABLE I
IONIZATION CHAMBERS

Type	Wall Material	Inside Dimensions		Volume (cm. ³)	r/Div.*
		Diameter	Length		
CX-1 Cylindrical	Bakelite	cm. 12.05	cm. 21.85	2490	0.23×10^{-3}
SX-11 Spherical	Polystyrene	10.5		624	0.79×10^{-3}
D-1 Thimble	Catalin	0.7	2.15	0.783	1.0

* Dose in roentgens per scale division of electrometer.

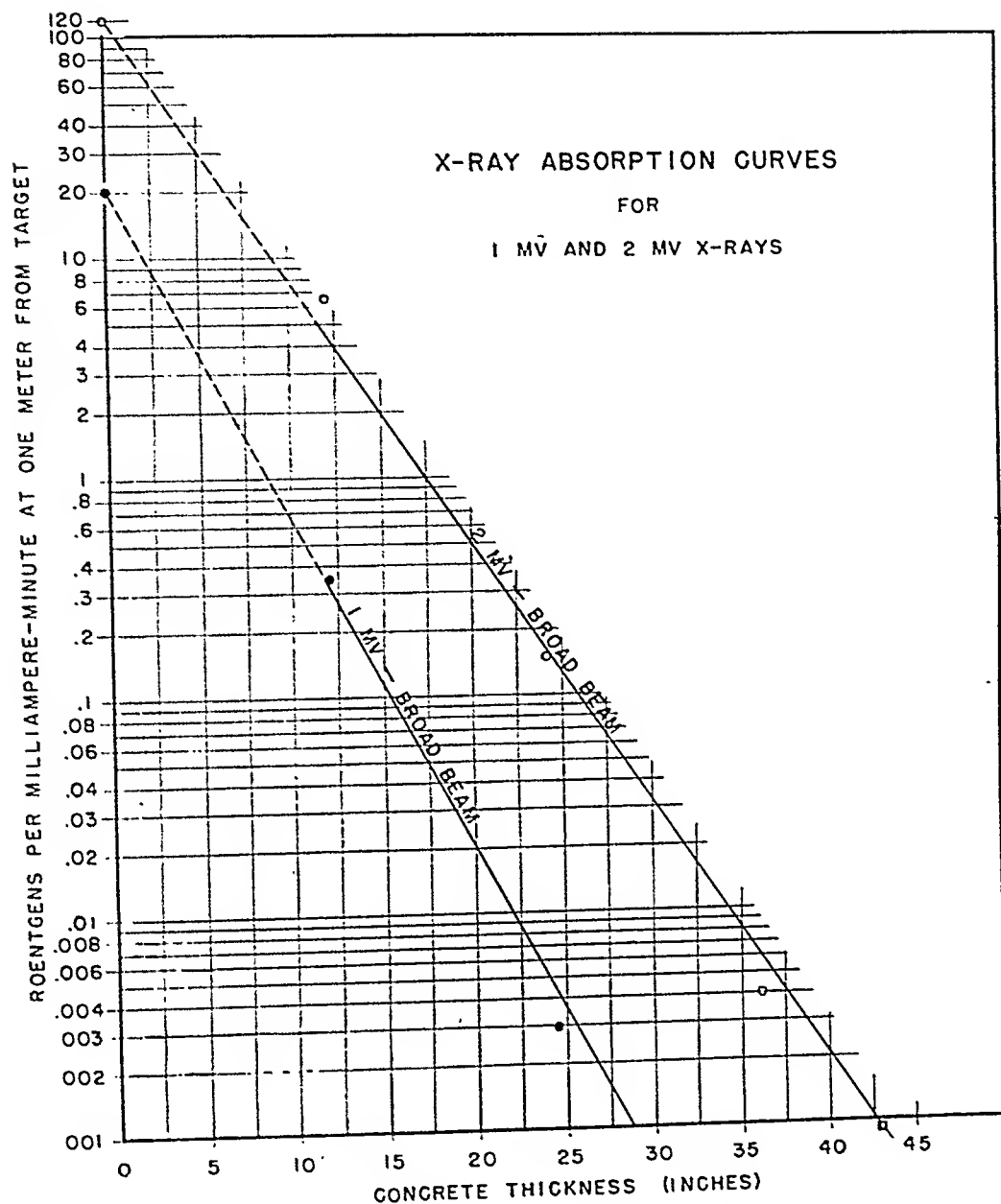


FIG. 2. Concrete absorption curves for 70° beams of 1 mv. and 2 mv. roentgen rays. All measurements were made with the radiation transmitted through a tungsten target along the tube axis. A resonance generator was used. The voltage waveform of such generators is sinusoidal. All indicated voltages are peak or crest values.

which is operative at both 1 and 2 mv.* All measurements were made with roentgen radiation transmitted through the tube target along the axis of the tube. The anode cone consisted of a cylinder with a lead wall 5 cm. thick, the end of which was shaped so as to confine the roentgen-ray beam to a cone of radiation measuring approximately 70° at its apex.

* We are indebted to the General Electric Company and to Dr. E. E. Charlton of their Research Laboratory for facilities which were made available to us in carrying out these experiments.

III. RESULTS

The attenuation curves obtained are shown in Figure 2. As a check on the reliability of the method used, transmission measurements for 2 mv. radiation through a solid concrete wall 42 inches thick of density 152 lb. per cu. ft. were also made. The single point so obtained is plotted in Figure 2 at a thickness of about 43 inches.

The effect of chamber-to-wall distance on the apparent attenuation is illustrated by the curves of Figure 3. The ordinate is

in arbitrary units. It is obtained by dividing the dose per milliamper-minute by the square of the sum of the distances E , F , and G . The abscissa is the chamber-wall distance, G , shown in Figure 1. If there were neither scattering in the wall nor absorption

also for the 1 mv. data on a 4° beam published by Folsom and Focht.² Accordingly, it may be concluded that within these limits the beam angle has no important effect on the change in apparent attenuation with chamber-to-wall distance.

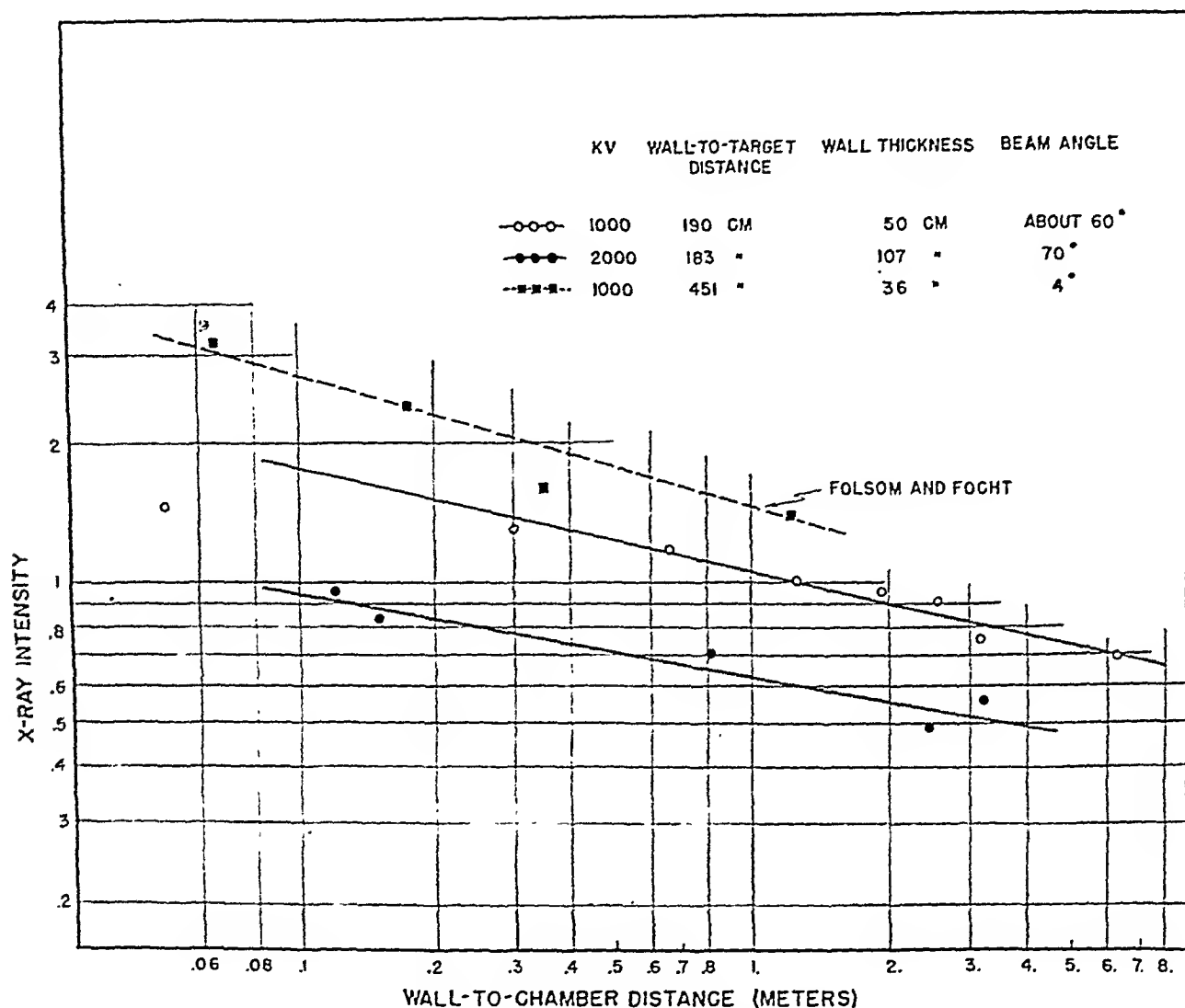


FIG. 3. Variation of roentgen-ray dose with distance from a concrete protective barrier. The abscissa is the distance to the ionization chamber measured from the side of the barrier from which the radiation emerges. The ordinate is obtained by dividing the dose per milliamper-minute by the square of the distance from the roentgen-ray source to ionization chamber.

in the air, each set of plotted points should give a straight line with zero slope. Actually, because of wall scattering, the value of the ordinate decreases with increase of abscissa. These plotted points fall along a straight line for each experimental setup. The slopes measured on a linear scale—not the logarithmic scale of Figure 3—are approximately 0.25. This is so not only for our own 1 mv. and 2 mv. data for 70° beams but

IV. CONCLUSIONS

From the data presented above it is possible to compute for broad roentgen-ray beams the thickness of concrete barriers necessary for protection against 1 mv. and 2 mv. roentgen radiation from targets of the transmission type. Such targets are standard in this quality range. In Table II the thickness of such barriers is listed for 1 mv. and 2 mv. roentgen radiation and for

TABLE II
THICKNESS OF CONCRETE OF DENSITY 147 POUNDS PER CUBIC FOOT REQUIRED FOR
PROTECTION AGAINST BROAD BEAMS OF ROENTGEN RAYS FOR THE
CURRENT, DISTANCE, AND VOLTAGE INDICATED

Target Distance	1 mv. Roentgen Rays				2 mv. Roentgen Rays			
Feet	0.5 ma.	1.0 ma.	2.0 ma.	3.0 ma.	0.5 ma.	1.0 ma.	2.0 ma.	3.0 ma.
	in.	in.	in.	in.	in.	in.	in.	in.
4	30.5	32.5	34.5	36.0	44.5	47.0		
5	29.5	31.5	33.5	34.5	43.0	45.5	48.0	49.5
6	28.0	30.0	32.5	33.5	42.0	44.5	47.0	48.5
8	26.5	28.5	30.5	32.0	39.5	42.0	44.5	46.0
10	25.0	27.0	29.5	30.5	38.0	40.5	43.0	44.5
15	23.0	25.0	27.0	28.0	35.0	37.5	40.0	41.5
21	21.0	23.0	25.0	26.5	33.0	35.5	38.0	39.5
30	18.5	20.5	22.5	24.0	30.0	32.5	35.0	36.5
40	17.0	19.0	21.0	22.0	28.0	30.5	33.0	34.5
50	15.5	17.5	19.5	21.0	26.0	28.5	31.0	32.5
75	13.5	15.5	17.5	18.5	23.0	25.5	28.0	29.5
100	11.5	13.5	15.5	17.0	21.0	23.5	26.0	27.5

the various tube currents and target distances normally encountered in practice. The tabular values given therein were computed directly from the absorption curves of Figure 2. A few points at short distances and high currents required linear extrapolation for their determination. Absorption of roentgen radiation by air has been neglected. A permissible daily dose of 0.1 roentgen has been assumed.^{7,8} It was further assumed that the dosage rate per milliamperere at 1 meter for a 1 mv. roentgen-ray generator is 20 r per minute and for a 2 mv. roentgen-ray generation, 120 r per minute, and that the person to be protected will normally be stationed near the protective barrier.

National Bureau of Standards
Washington, D. C.

REFERENCES

1. JAEGER, R., and TROST, A. *Elektrotechn. Ztschr.*, 1940, 61, 1025.
2. FOLSOM, T. R., and FOCHT, E. F. Data on attenuation of narrow and broad beams of 1,000 kilovolt (peak) roentgen rays by lead, concrete and water. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1944, 51, 76-82.
3. SINGER, G., and LAURENCE, G. C. Materials and methods of x-ray protection. *Indust. Radiography*, 1945, 4, 35. Also, *Radiology*, 1946, 46, 69-76.
4. FAILLA, G. Protection against high energy roentgen rays. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1945, 54, 553-582.
5. BRAESTRUP, C. B. X-ray protection in diagnostic radiology. *Radiology*, 1942, 38, 207-216.
6. CHARLTON, E. E., and WESTENDORP, W. F. *Electronics*, 1944, 17, 128.
7. X-ray Protection. National Bureau of Standards Handbook HB20, 1936.
8. Safety Code for the Industrial Use of X-rays. American Standards Association, New York, N. Y., 1946.



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E D I T O R I A L

THE USE OF RADIOACTIVE ISOTOPES IN LEUKEMIA

DURING the past few years considerable attention has been focused on the study of leukemia, mainly because of the increasing availability of radioactive isotopes. In general, the biological effect of the radioactive isotopes is the result of the action of the emitted rays which are similar to those given off by radium. However, it was thought that due to inherent variation in the relative proportion of these rays and due to the many possible half-lives with the different isotopes, a new therapeutic agent could be found which would lead to irradiation of leukemia in a more efficient manner than is the case with radium or the roentgen rays.

The first attempts¹ were made with radiophosphorus (P^{32}). This element possesses properties which make it particularly attractive for investigations in leukemia. Aebershold² who produced radiophosphorus by deuteron bombardment of the stable red phosphorus in the cyclotron found the following important advantages: (1) radiophosphorus has a half-life of 14.2 days, the administered dose decaying in a few months to an imperceptible amount; (2) in contradistinction to radium which emits alpha, beta and gamma rays, it gives off only beta rays which have energies up to 1.8 mev., the average energy being approximately 0.6 mev., and (3) its chemical behavior is the same as that of ordinary phosphorus, thus taking an active part in the phosphorus metabolism of the body.

In 1942, Low-Beer, Lawrence and Stone³

were already able to publish some definite data on the physical and biological background of the use of radiophosphorus and to give a brief account of its therapeutic possibilities in leukemia. Experimental studies in animals showed that radioactive phosphorus deposits with predilection in those tissues which normally have a higher phosphorus uptake, such as bone, spleen, liver and the lymph nodes. In leukemia, lymphoma and lymphosarcoma a greater percentage of radiophosphorus was concentrated in the pathologic tissues than in any of the normal tissues, except bone. As a rule, the greater the metabolic activity of a pathologic lymphoid cell, the greater was the uptake. It appeared that the more rapid synthesis of nucleoproteids in the actively growing cells required an increasing amount of phosphorus from the blood stream.

The fact that radiophosphorus emits only soft beta rays together with this rather selective deposition in pathologic lymphoid tissues suggested that an efficient procedure may be worked out for uniform internal irradiation of leukemia and allied diseases. In order to obtain an exposure over a longer period of time, Low-Beer, Lawrence and Stone³ devised various methods. In using the simple saturation method, which is very much along the same line as Pfahler's saturation method for the roentgen rays, a large initial dose was given at the onset of the treatment and this was brought up to its original level every third day by making up the difference due to natural decay and loss by excretion. A second method was the fractional saturation in which a desired level was built up by small equal or by gradually increasing frac-

¹ Lawrence, J. H., Scott, K. G. and Tuttle, L. W. Studies on leukemia with the aid of radioactive phosphorus. *Internat. Clin.*, 1939, 3, 33-58; also, Warren, S. Treatment of leukemia by radioactive phosphorus. *New England J. Med.*, 1940, 223, 751-754.

² Aebershold, P. C. The cyclotron: a nuclear transformer. *Radiology*, 1942, 39, 513-540.

³ Low-Beer, B. V. A., Lawrence, J. H., and Stone, R. S. Therapeutic use of artificially produced radioactive substances; radio-

phosphorus, radiostrontium, radioiodine, with special reference to leukemia and allied diseases. *Radiology*, 1942, 39, 573-597.

tions and maintained at the same height for a shorter or longer period. Finally, in a third method, which was called the fractional method, equal fractions of radiophosphorus were given at regular or gradually spaced intervals until the desired effect was produced. Considerable effort was spent in calculating the retained activity and the radiation level, or the maximum total exposure of the body, attained at the time of the administration of each dose. Although none of these methods led to a continuously uniform exposure and the radiation levels showed fluctuations due to the variation in the utilization of the doses given, clinically the fractional method with intravenous injection of the radiophosphorus proved a simple and convenient procedure. A review of the literature reveals that the great majority of the investigators in later work preferred the same procedure. The individual dose varied between 0.5 and 3 millicuries and was given once a week followed by gradually spaced intervals until the blood count became approximately normal.

The selective uptake of radiophosphorus by normal and leukemic tissues of humans was studied by a number of authors. Warren,⁴ on the basis of postmortem examinations performed in 10 leukemic patients who died one to thirty-five days after the administration of the last dose of radiophosphorus, confirmed the increased concentration in all leukemia infiltrations. He also found that the liver, spleen, kidney and bone marrow contained relatively larger amounts of radiophosphorus than such slowly metabolizing tissues as brain, fat and cartilage, a fact already known from animal experiments.

In additional reports⁵ Warren, from clinical observations, gave data and graphs of the retention and rate of excretion of the radiophosphorus. Essentially, they agreed

with those of Low-Beer, Lawrence and Stone.³ Finally, in 1945, he presented the results in 81 cases of leukemia, myeloma, Hodgkin's disease and polycythemia vera treated with radiophosphorus, most of which were far advanced or refractory to roentgen therapy. In 47 per cent of the patients with chronic myelogenous leukemia and 63 per cent of the patients with chronic lymphatic leukemia a temporary improvement was noted. The most important observation was that radiophosphorus produced radiation sickness only in rare instances.

A very comprehensive study on radioactive phosphorus as a therapeutic agent was published by Reinhard, Moore, Bierbaum and Moore.⁶ These authors collected all the cases from the literature which were treated in one form or another with radiophosphorus and compared the results, as far as this was possible, with the results obtained in 155 cases of their own. In regard to myelogenous leukemia it was found that there were nine reports in the literature dealing with 107 cases and the authors themselves had 39. There was good agreement that in acute myelogenous leukemia radiophosphorus remained ineffective. In the chronic cases its administration restored the leukocyte count to normal or approximately normal in the majority of instances, a fact which was followed quite consistently by symptomatic improvement. The cases from the literature, with few exceptions, did not permit an evaluation of the final results but an analysis of the authors' series showed that in those patients who had already died the average duration from onset of symptoms to death was 3.64 years. In the subjects still living the average duration was 31.1 months, 3 cases having been treated for more than three years. The group of lymphatic leukemia included 120 cases collected from

⁴ Warren, Shields. Distribution of doses of radioactive phosphorus in leukemic patients. *Cancer Research*, 1943, 3, 334-336.

⁵ Warren, Shields. Retention of radioactive phosphorus in leukemic patients. *Cancer Research*, 1943, 3, 872-876; also, Therapeutic use of radioactive phosphorus. *Am. J. M. Sc.*, 1945, 209, 701-711.

⁶ Reinhard, E. H., Moore, C. V., Bierbaum, O. S., and Moore, S. Radioactive phosphorus as a therapeutic agent; review of the literature and analysis of the results of treatment of 155 patients with various blood dyscrasias, lymphomas, and other malignant neoplastic diseases. *J. Lab. & Clin. Med.*, 1946, 31, 107-218.

ten reports in the literature and 45 personal cases. As in myelogenous leukemia, the acute cases showed no significant response. In the chronic cases, those who had already died had an average survival from onset of symptoms to death of 31.8 months and in the remaining the average duration of the disease amounted to 36.3 months. A comparison of these figures with data of older statistics of untreated leukemias or leukemias treated principally with radiation therapy is interesting. In 1924 Minot, Buckman and Isaacs⁷ determined the average duration from onset of symptoms to death as being 3.04 years for chronic myelogenous leukemia and 3.33 years for chronic lymphatic leukemia, without treatment. In 1934, a collective review⁸ of a rather large number of cases revealed that if roentgen (or radium) therapy was used the average survival from onset of symptoms varied between 3 and 4.1 years for chronic myelogenous leukemia and 2.75 and 4.33 years for chronic lymphatic leukemia.

The impression was gained by Reinhard, Moore, Bierbaum and Moore⁶ that treatment with radiophosphorus in any type of chronic leukemia "is probably as satisfactory as, but no better than, X-radiation in relieving symptoms and in prolonging life." As in the observations of Warren, the chief advantage of radiophosphorus over roentgen therapy was found to be in the freedom from radiation sickness. However, roentgen therapy was noted to be more effective than radiophosphorus in bringing about a rapid regression of the enlarged spleen and lymph nodes. In such instances an association of the two therapeutic agents had definite merit. In the acute leukemias, as already stated, and in monocytic leukemia, radiophosphorus remained without value.

During the course of these studies, it was soon suspected that the administration of radiophosphorus in leukemia must also have a harmful effect when there is already too much depletion of the bone marrow present or when the dose is too large. Thus Warren⁵ observed that radiophosphorus was absolutely useless in all those instances in which but little hematopoietic tissue remained. Likewise Reinhard, Moore, Bierbaum and Moore⁶ found that severe leukopenia, thrombocytopenia, and anemia may occur as complications of radiophosphorus therapy. As a rule, the leukocyte level decreased first, the thrombocyte level second and the erythrocyte level was affected last. There was a wide variation in the dose leading up to these complications, so that no accurately corresponding radiation levels could be established. The problem was further complicated by the difficulty of precisely assaying the activity of the radiophosphorus itself.

Graff, Scott and Lawrence,⁹ to gain additional knowledge on the limiting factors of the use of radiophosphorus, performed a series of experiments with transmissible lymphoma in mice. As was expected the radiophosphorus localized with predilection in lymphomatous infiltrations, spleen and liver. It was found, however, that when the dose was raised to the point where it would destroy the lymphomatous infiltrations, all elements of the hematopoietic system, including leukocytes, thrombocytes and erythrocytes, were temporarily depressed. When the dose was raised further, the bone marrow was destroyed. From past experience with roentgen therapy it is known that cells following repeated irradiation acquire a certain radioresistance. It is probable, therefore, that in treating leukemia with radiophosphorus the stage is eventually reached when both leukemic and normal cell elements are being equally irradiated. This means that the threshold of selective action is not as high as was ori-

⁷ Minot, G. R., Buckman, T. E., and Isaacs, R. Chronic myelogenous leukemia; age incidence, duration, and benefit derived from irradiation. *J. A.M.A.*, 1924, 82, 1489-1494; also, Minot, G. R., and Isaacs, R. Lymphatic leukemia; age incidence, duration and benefit derived from irradiation. *Boston M. & S. J.*, 1924, 191, 1-9.

⁸ Leucutia, T. Irradiation in lymphosarcoma, Hodgkin's disease and leukemia; statistical analysis. *Am. J. M. Sc.*, 1934, 188, 612-623.

⁹ Graff, W. S., Scott, K. G., and Lawrence, J. H. Histologic effects of radiophosphorus on normal and lymphomatous mice. *Am. J. ROENTGENOL. & RAD. THERAPY*, 1946, 55, 44-54.

ginally surmised. For the same reason, and since leukemia is such a diffuse disease, Graff, Scott and Lawrence⁹ believe that the chances of finding a method of true selective irradiation are not very great.

Another type of isotope was tried by Thygesen, Vidabaek and Villaume.¹⁰ These authors, in 1944, published a preliminary report on the treatment of leukemia with radiosodium (Na^{24}). The main difference between radiophosphorus and radiosodium is that the latter possesses no selective avidity but distributes itself through the extra- and intracellular fluid, maintaining an almost constant radiation level in the blood stream. Other distinguishing features are that the radiosodium emits beta rays and very hard gamma rays, and that its half-life is only 14.8 hours. Because of these factors, radiosodium acts more like "spray" roentgen therapy producing a rather uniform irradiation of the whole body. Thygesen, Videbaek and Villaume treated 7 cases of chronic lymphatic leukemia with apparently favorable results, but since the period of observation did not exceed 150 days no statement can be made as to the final value of the treatment. On the other hand, Lindgren,¹¹ who treated 5 cases of leukemia comparatively with radiosodium and radiophosphorus, found a rather poor response to radiosodium and a much better response to radiophosphorus. A very valuable report on the comparative study of the

effects of radioactive sodium and of whole body roentgen irradiation on white mice was presented by Evans and Quimby.¹² A great similarity was noted between the two types of radiation suggesting that a like behavior occurs also in the human.

An excellent review was published recently by Furth¹³ surveying all experimental aspects of the last few years, aiming to throw some light on the nature and genesis of leukemia. In summarizing the results of this review, Furth arrived at the conclusion that if diverse extrinsic and genetic factors act on a normal hematopoietic cell a transformation into a leukemic cell with a heightened growth force may follow. The basic change may be due (a) to a cytoplasmic or nuclear alteration of the reproductive material of the cell, (b) to the presence of a self-perpetuating exogenous agent, perhaps a virus, and (c) to an autocatalytically multiplying endogenous growth factor which causes abnormal differentiation. The leukemic cell, once on its way, exhibits complete independence of growth, invading tissues and organs and ultimately killing the host.

In the face of this latest theory and considering the limitations of all available forms of irradiation, it is probable that the curative treatment of leukemia will remain a problem difficult of solution for some time to come.

T. LEUCUTIA

¹⁰ Thygesen, J. E. Videbaek, A. and Villaume, I. Treatment of leukemia with artificial radio-active sodium; preliminary report. *Acta radiol.*, 1944, 25, 305-316.

¹¹ Lindgren, E. Versuche mit radioaktiven Isotopen bei Leukämiebehandlung. *Acta radiol.*, 1944, 25, 614-624.

¹² Evans, T. C., and Quimby, E. H. Studies on the effect of radioactive sodium and of roentgen rays on normal and leukemic mice. *AM. J. ROENTGENOL. & RAD. THERAPY*, 1946, 55, 55-56.

¹³ Furth, J. Recent experimental studies in leukemia. *Physiol. Rev.*, 1946, 26, 47-76.



SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

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Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: 1947, to be announced.

AMERICAN COLLEGE OF RADIOLOGY

Secretary, Mac F. Cahal, 20 N. Wacker Drive, Chicago 6. Annual meeting: 1947, to be announced.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION

Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio. Annual meeting: 1947, to be announced.

AMERICAN RADIUM SOCIETY

Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: 1947, to be announced.

ALABAMA RADIOLOGICAL SOCIETY

Secretary, Dr. John D. Peake, Mobile Infirmary, Mobile Ala. Next meeting time and place of Alabama State Medical Association.

ARKANSAS RADIOLOGICAL SOCIETY

Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

RADIOLOGICAL SOCIETY OF NORTH AMERICA

Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Palmer House, Chicago, Ill., Dec. 1-6, 1946.

RADIOLOGICAL SECTION, BALTIMORE MEDICAL SOCIETY

Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION

Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY

Secretary, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11, Conn. Meets bi-monthly on second Thursday, at place selected by Secretary.

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RADIOLOGICAL SECTION, LOS ANGELES CO. MED. ASSN.

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Cleveland, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

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DENVER RADIOLOGICAL CLUB

Secretary, Dr. W. C. Huyler, 1619 Milwaukee, Denver 6, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY

Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Dell, Jr., 333 W. Main St., S., Gainesville, Fla. Meetings in May and November.

GEORGIA RADIOLOGICAL SOCIETY

Secretary, Dr. James J. Clark, 478 Peachtree St., Atlanta, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

RADIOLOGICAL SOCIETY OF KANSAS CITY

Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY

Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY

Secretary, Dr. J. A. Campbell, Indiana University Hospitals, Indianapolis 7. Meets second Sunday in May.

IOWA X-RAY CLUB

Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KENTUCKY RADIOLOGICAL SOCIETY

Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY

Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

LOUISIANA RADIOLOGICAL SOCIETY

Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS

Secretary, Dr. E. M. Shebesta, 1429 David Whitney Bldg., Detroit. Three meetings a year, Fall, Winter, Spring.

MILWAUKEE ROENTGEN RAY SOCIETY

Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY

Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association, the other in the fall.

NEBRASKA RADIOLOGICAL SOCIETY

Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Neb. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

NEW ENGLAND ROENTGEN RAY SOCIETY

Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library

NEW HAMPSHIRE ROENTGEN RAY SOCIETY

Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

RADIOLOGICAL SOCIETY OF NEW JERSEY

Secretary, Dr. W. H. Seward, Orange Memorial Hospital, Orange, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

NEW YORK ROENTGEN SOCIETY

Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 p.m.

NORTH CAROLINA RADIOLOGICAL SOCIETY

Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY

Secretary, Dr. L. A. Nash, St. John's Hospital, Fargo. Meetings held by announcement.

CENTRAL NEW YORK ROENTGEN RA SOCIETY

Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year. January, May, November.

OHIO RADIOLOGICAL SOCIETY

Secretary, Dr. Henry Snow, 1061 Reibold Bldg., Dayton, Ohio. Meets during annual meeting of Ohio State Medical Association.

OKLAHOMA STATE RADIOLOGICAL SOCIETY

Secretary, Dr. P. E. Russo, 230 Osler Bldg., Oklahoma City, Okla. Three regular meetings annually.

ORLEANS PARISH RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC ROENTGEN SOCIETY

Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

PHILADELPHIA ROENTGEN RAY SOCIETY

Secretary, Dr. C. L. Stewart, Jefferson Hospital. Meets first Thursday of each month, October to May, at 8:00 p.m., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY

Secretary, Dr. L. M. J. Freedman, 115 South Highland Ave. Meets 6:30 p.m. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

PORTLAND ROENTGEN CLUB

Secretary, Dr. Selma Hyman, University of Oregon Medical School, Portland, Oregon. Meets monthly 2d Wednesday, 8:00 p.m., Library of University of Oregon Medical School.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.

Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 p.m. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

Secretary Dr. A. M. Popma, 220 N. First St., Boise, Idaho.

ST. LOUIS SOCIETY OF RADIOLOGISTS

Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY

Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

SAN FRANCISCO RADIOLOGICAL SOCIETY

Secretary, Dr. Joseph Levitin, 516 Sutter St., San Francisco 2, Calif. Meets monthly on the third Thursday at 7:45 p.m., first six months of the year at Lane Hall, Stanford University Hospital, and second six months at Toland Hall, University of California Hospital.

SHREVEPORT RADIOLOGICAL CLUB

Secretary, Dr. R. W. Cooper, Charity Hospital, Shreve-

port, La. Meets monthly on third Wednesday, at 7:30 p.m., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY

Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY

Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY

Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING

Meets each Monday evening from September to June, at 7 p.m. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE

Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 p.m., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

UTAH RADIOLOGICAL CONFERENCE

Secretary, Dr. Henry H. Lerner, School of Medicine, University of Utah, Salt Lake City 1. Meets 1st and 3rd Thursdays monthly from 7:30 to 10 p.m., Salt Lake County General Hospital, September to June.

UTAH STATE RADIOLOGICAL SOCIETY

Secretary, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

VIRGINIA RADIOLOGICAL SOCIETY

Secretary, Dr. E. L. Flanagan, 116 E. Franklin St., Richmond, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY

Secretary, Dr. Thomas Carlile, 1115 Terry St., Seattle. Meets fourth Monday each month, October through May, College Club, Seattle.

X-RAY STUDY CLUB OF SAN FRANCISCO

Secretary, Dr. J. M. Robinson, University of California Hospital. Meets monthly, third Thursday evening.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA

President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGIA Y FISIOTERAPIA

General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE ROENTGEN SOCIETY

Medical Members' meeting held monthly on third Friday at 2:30 p.m. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)

Meets third Friday each month at 4:45 p.m. at the Royal Society of Medicine, 1 Wimpole St., London.

FACULTY OF RADIOLOGISTS

Secretary, Dr. M. H. Jupe, 23 Welbeck St., London, W.1 England.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS

Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION

Secretary, Dr. Keith Hallam, St. George's Hospital,

K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to November inclusive.
CANADIAN ASSOCIATION OF RADIOLOGISTS
Honorary Secretary, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.
SOCIÉTÉ CANADIENNE-FRANCAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES
Secretary, Dr. Origène Dufresne, 4120 Ontario St., East, Montreal, P. Q.
SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.
RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

SOUTH AMERICA

SOCIEDAD ARGENTINA DE RADIOLOGIA
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.
SOCIEDAD PERUANA DE RADIOLOGIA
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306 Lima, Peru. Meetings held monthly except during January, February and March, at the Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

CONTINENTAL EUROPE

CESKOSLOVENSKÁ SPOLEČNOST PRO RÖNTGENOLOGII A RADIOLOGII V PRAZE
Secretary: MUDr. Roman Blána, Praha XII, Kounický 160, Czechoslovakia.
SOCIEDAD ESPAÑOLA DE RADIOLOGIA Y ELECTROLOGIA
Secretary, Dr. J. Martín-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.
SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. Babaiantz, Geneva.
Secretary for German language, Dr. Max Hopf, Effingerstrasse 49, Bern. Meets annually in different cities.
SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.
ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD: USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

SCANDINAVIAN ROENTGEN SOCIETIES
 The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

MINNESOTA RADIOLOGICAL SOCIETY

The fall meeting of the Minnesota Radiological Society was held in Rochester, Minnesota, on October 26, 1946. The following papers were presented:

Dr. S. F. Haines, Rochester. Radioactive Iodine in the Treatment of Exophthalmic Goiter.

Dr. J. J. Wells, Rochester. Unusual Case of Giant Cell Tumor of Bone Treated with X-ray.

Dr. E. T. Leddy, Rochester. X-ray Treatment of Malignancy of the Testis.

Dr. L. M. Vaughan, Rochester. Review of Different Methods of Radium Therapy for Carcinoma of the Cervix.

Dr. H. H. Bowing, Rochester. Essential Principles of Radium Therapy for Carcinoma of the Cervix.

Dr. R. E. Fricke, Rochester. Role of Alpha and Beta Particles in Radium Therapy.

Dr. M. M. D. Williams, Rochester. Loss of Radon from Radon Ointment.

Dr. John D. Camp, Rochester. Amebiasis in Naval Personnel.

Dr. Harry M. Weber, Rochester. A Case of Diffuse Lymphomatous Involvement of the Colon.

Dr. H. B. Burchell, Rochester. The Clinical Syndrome Associated with Pulmonary Arteriovenous Fistula.

Dr. H. B. Burchell and Dr. O. T. Clagett, Rochester. Motion Picture: A Case of Pulmonary Arteriovenous Fistula.

Dr. B. R. Kirklin, Rochester. The Diagnosis of Carcinoma of the Stomach by Chest Roentgenography.

Dr. C. Allen Good, Rochester. Thymic Tumor Associated with Myasthenia Gravis.

Dr. David G. Pugh, Rochester. Scleroderma of the Viscera.

Dr. John R. Hodgson, Rochester. Lesions of the Small Bones of the Feet: Neurotrophic or Infectious?

CANCER TEACHING DAY

A Cancer Teaching Day was held at Poughkeepsie, New York, on November 6, 1946. The following papers were given:

Dr. Chester O. Davison, Poughkeepsie. Five Year Cancer Survivals: The Experience of the Dutchess County Tumor Clinic.

Dr. John H. Farrow, New York. Diagnostic and Therapeutic Problems in Cancer: The Experience of the Dutchess County Tumor Clinic.

Dr. Martha E. Howe, New York. The Public Demand for Prevention and Early Diagnosis; A Sound Response.

Dr. George N. Papanicolaou, New York. Other Types of Cell Smear in Diagnosis of Cancer.

Dr. Maurice Fremont-Smith, Boston. The

Vaginal Smear in the Early Diagnosis of Cancer of the Uterus.

INDIAN JOURNAL OF RADIOLOGY

At the First Indian Congress of Radiology, held at Madras during February 13-16, 1946. it was decided to publish a journal entitled "*The Indian Journal of Radiology*" under the auspices of the Indian Radiological Association. This will be a quarterly publication. The editors, Dr. P. Ramma Rau and Dr. K. M. Rai, 155 Poonamallee High Road, Kilpauk, Madras, India, will be pleased to receive from radiologists original articles or case reports for publication in the Journal. The Journal will be published on art paper and it will therefore be possible to make a satisfactory reproduction of roentgenograms and other illustrations.

DAVID ANDERSON-BERRY PRIZE (1947)

A David Anderson-Berry Silver-Gilt Medal, together with a sum of money amounting to about £100, will be awarded during 1947 by the Royal Society of Edinburgh to the person who, in the opinion of the Council, has recently produced the best work on the therapeutic effect of roentgen rays on human diseases.

Applications for this prize are invited. They may be based on both published and

unpublished work and should be accompanied by copies of the relevant papers.

Applications must be in the hands of the General Secretary, Royal Society of Edinburgh, 22 George St., Edinburgh 2, *not later than January 31, 1947.*

It should be noted that an extension of the period allowed for the receipt of papers has been made.

OKLAHOMA STATE RADIOLOGICAL SOCIETY

The Oklahoma State Radiological Society was organized on October 28, 1946. The following officers were elected: *President*, Dr. J. E. Heatley, Oklahoma City; *Vice-President*, Dr. W. E. Brown, Tulsa; *Secretary-Treasurer*, Dr. P. E. Russo, Oklahoma City. The society plans to hold three regular meetings during each year.

CLINICAL CONFERENCE OF MID-WESTERN RADIOLOGISTS

The Seventh Annual Clinical Conference of Mid-Western Radiologists will be held in Cleveland, Ohio, on Friday and Saturday, February 14 and 15, 1947, at the Stadler Hotel. An excellent program has been arranged with emphasis on the clinical aspects of radiology. Announcements of the meeting will be mailed to mid-western radiologists early in January.



DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave.
Charleston, S. C.

A SIMPLE PORTABLE WATER PHANTOM*

By JAMES F. MARVIN, M.S.

University of Minnesota

MINNEAPOLIS, MINNESOTA

THE water phantom which was constructed for use in "depth dose" and "bone dose" measurements has proved to be a simple and portable device. Special measurements with two or more ionization chambers of the condenser r-meter type and with bony

Water Phantom

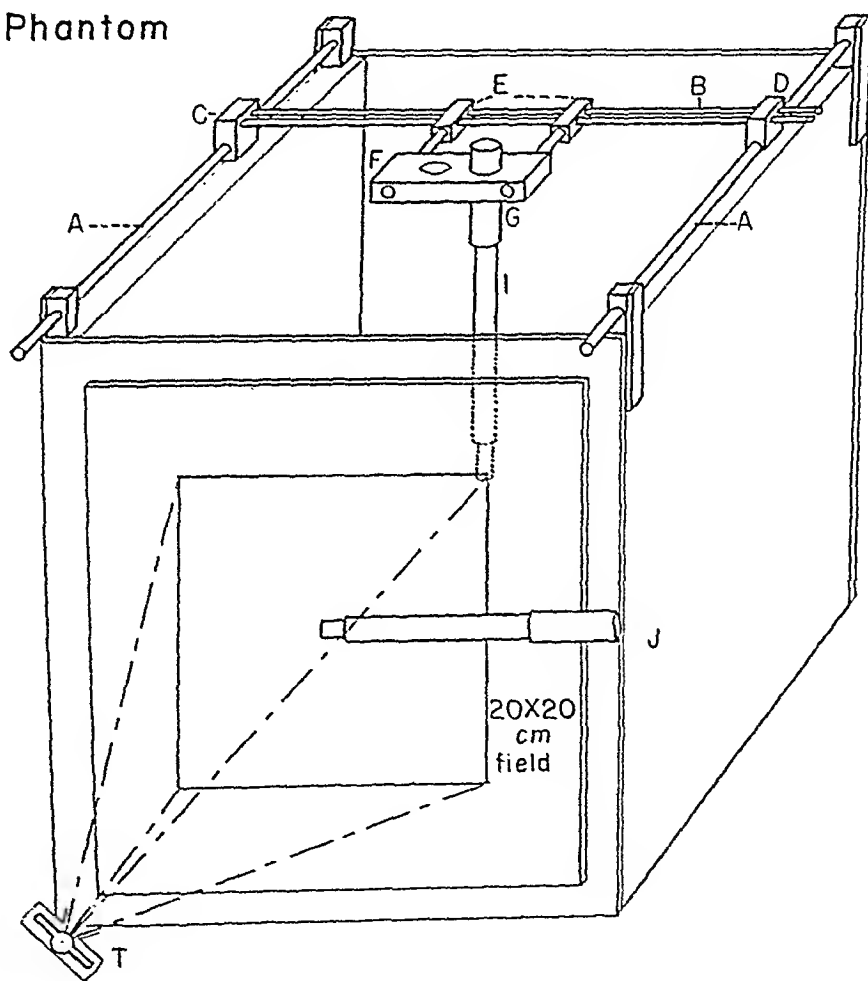


FIG. 1

be so easily and rapidly manipulated that a note on its construction seemed worth while. Less difficulty has been encountered in its use than with the customary presd-

structures as the pelvis or skull are easily made.

Construction is clearly shown in the accompanying drawing. The box, $15 \times 15 \times 15$

* From the Department of Radiology and Physical Therapy of the University of Minnesota and The University Hospitals, Minneapolis, Minn.

inches, has a wood base and sides. The two ends are of presdwood, which has a specific gravity of 1.03. A second sheet of presdwood is fastened on the front surface of the phantom. This sheet is cut to allow the ionization chamber to be placed half in presdwood and half in air for surface measurements.

The portions of the metal supporting structure for the chambers are: *A* and *B*, 5/16 inch steel rod; *C*, the hinge, which allows the rods *B* and other elements attached to *B* to rotate, removing the chamber *I* from the water; *D*, a stop, resting on rod *A*; *C* and *D* slide along *A* to allow for adjustment of depth in the roentgen-ray field. Clamps are put in place beside *C* and *D* on rod *A*, to maintain the same position for a series of readings. Supports *E* fasten on rods *B* at any desired lateral position in the field. Metal block *F* is designed to support two chambers in such a position that secondary radiation from one chamber will not seriously affect the reading of the second chamber. *G*, the cap of the r-meter chamber, may be moved vertically and clamped in place for any desired depth in the water. *I* shows the position of the ionization chamber in the water and *J* shows the position of the chamber for surface measurements. The two readings were not taken simultaneously as the absorption by the brass of chamber *J* may affect the reading of chamber *I*. Rather, a monitor chamber was introduced, with the thimble just penetrating the corner of the

field. *T* represents the roentgen tube, shown in the drawing at 50 cm. distance from the surface of the phantom.

The chamber with the lucite thimble was found to be watertight. Other chambers may be made watertight with collodion, or may be immersed in a rubber sheath. It has been shown that this procedure does not alter the readings.

Leakage has occurred in the chambers in only two instances. Water affected the cement material used in the bone ionization chamber, and allowed water to enter the thimble. In the other instance, a chamber was accidentally dropped in the water. Amber and polystyrene are sufficiently non-hygroscopic that they are not affected by the water and did not develop leakage even when the chambers were left immersed in the water for forty-eight hours.

For depth dose measurements, a precaution should be noted. Measurement at the surface must be made with a dry chamber, and the temperatures of the water and air must be the same (or a correction may be made in the readings to take account of any temperature difference).

University Hospitals
Minneapolis 14, Minn.

REFERENCE

1. STENSTROM, K. W., and MARVIN, J. F. Ionization measurements with bone chambers and their application to radiation therapy. *AM. J. ROENTGENOL. & RAD. THERAPY*, October, 1946, 56, 759-770.



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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

WRIGHT, R. WESLEY. Aero-otitis media; further report of purulent otitis media complicating aero-otitis media. *Ann. Otol., Rhin. & Laryng.*, Sept., 1945, 54, 499-512.

The author reports on his observations concerning aero-otitis media as seen at an Army Air Base and Preflight School. Thirty-nine cases of purulent otitis media complicating aero-otitis media have been studied.

The ear symptoms experienced in flight are described as follows: During ascent there are usually no disagreeable symptoms. There may be a feeling of fullness and diminished hearing followed by a clicking sensation with clearing as air in the middle ear, now under greater pressure than the surrounding air, passes down the eustachian tube. When level flight is reached no further inequalities exist between the air in the middle ear and that of the outside, and no symptoms are experienced. It is seldom that this equalization is not accomplished on ascent. Descent is the critical time for the development of the ear symptoms. While any marked inequality between air in the middle ear and air of the surroundings will cause symptoms of stuffiness, pain, and hearing loss, actually this inequality occurs only on descent (except in rare cases).

Predisposing Pathological Changes Responsible for Aero-otitis Media. In general, upper respiratory infections, nasopharyngitis, sore throat, colds and sinusitis account for most of the acute conditions which are complained of as the predisposing cause. Of more specific interest are the findings in the epipharynx. The torus tubarius almost always shows marked inflammatory changes. The inflammatory swelling may obliterate the tubal orifice completely. Adenoid tissue, which is usually present in the vault, extends laterally and impinges on the torus tubarius. Usually there is little to be seen in the throat or anterior nose and the pathologic findings may be visualized only nasopharyngoscopically.

Fowler found a great number of flyers in England suffering from otitis media and aero-

otitis media and in these patients, hyperplasia of the pharyngeal lymphoid tissue seemed to account for the condition.

Frequency. The incidence of aero-otitis media is about 6 per cent. By comparison, the incidence of aërosinüsitis is a little over 1 per cent.

Symptomatology and Pathological Findings in the Ear.

1. Pain which may occasionally be so severe as to cause unconsciousness and shock.
2. Nausea, vomiting and dizziness.
3. A feeling of stuffiness usually supervenes after the pain disappears.
4. The drum is usually hemorrhagic and retracted if the pain is marked. When the process is moderate, there is only reddening along the handle of the malleus and around the periphery as in a beginning otitis media.
5. There is usually a moderate degree of hearing loss.
6. In practically every case of aero-otitis media there is sooner or later fluid in the middle ear. The fluid is a transudate drawn from the blood vessels of the middle ear as a result of the negative pressure.

Treatment.

1. Preventive—No difficulty should arise if no marked upper respiratory pathology exists and if the subject is aware of the possibility of ear blockage and is taught one of the various methods of opening the eustachian tube. Before the flight it is the practice of the author to have all men with any indication of upper respiratory infection ventilate the middle ear by the Valsalva method. The examiner watches the middle ear with an otoscope to see if the inflation is successful.
2. Treatment of the actual condition—The pain usually disappears within a short time. Inflation helps if stuffiness and hearing loss persists.
3. Treatment of the underlying pathology—The adenoid tissue seems to be the all important pathologic factor in the production of aero-otitis media. Those men having only respiratory disease without adenoid tissue rarely suffer from aero-otitis.

Therefore, to prevent future attacks of aerotitis, the adenoid tissue is eliminated. If a large mass of adenoid tissue is found it is removed surgically. If the adenoid tissue is around the tubes and in the vault, which is its usual location, it is treated by irradiation in fractional doses. Radium has not been available to the author so roentgen therapy has been used exclusively. Those treated have responded well. Many men having repeated attacks of aerotitis media have been freed of any difficulty on subsequent flights by this treatment.—*Mary Frances Vastine*.

ROSEDALE, RAYMOND S. Massive fibroma of the maxillary antrum as a part of multiple neurofibromatosis in siblings. *Arch. Otolaryng.*, Sept., 1945, 42, 208-211.

Von Recklinghausen's disease or multiple neurofibromatosis is familial and sometimes congenital. In reviewing the inherited abnormalities of the skin in this disease, one investigator concluded that in a few families the defect is inherited as a dominant.

Clinical Picture. The disease is characterized by the association of multiple tumors of the nervous system (including the sympathetic, motor and sensory nerves). Sometimes there are associated abnormalities of the endocrine and vascular systems. Not infrequently café au lait spots of the skin accompany the disease.

Ewing reported associated defects, such as gliosis and tuberous sclerosis of the brain and spinal cord, spina bifida and meningocele. He also mentioned the association of various types of nevi and melanomas, localized and generalized elephantiasis and abnormalities of the bones. He specifically mentioned involvement of the mucous membranes. The superficial tumors are usually symptomless and become objectionable only because of their size, location, traumatization or multiplicity. More deeply seated tumors may cause symptoms because of anatomic tamponage occurring as a natural development in their growth.

Gross and Microscopic Pathology. Grossly the tumors are smooth, pearly gray and usually firm. They are easily separated from the surrounding tissues.

The tumors are usually multiple and their blood supply is poor. They grow slowly and are benign. They are subject to hyaline, fatty or mucoid degeneration. Calcification is sometimes seen.

Microscopically, the tumors consist, for the most part, of parallel and interlaced bundles of collagen and fibrous tissue with some tendency toward palisading of the nuclei.

Two case reports, one in a brother and the other in his sister, are presented. In both instances a massive maxillary fibroma was seen in association with Von Recklinghausen's disease.—*Mary Frances Vastine*.

MALINIAC, JACQUES W. Fracture-dislocations of the cartilaginous nose; anatomicopathologic considerations and treatment. *Arch. Otolaryng.*, Aug., 1945, 42, 131-137.

The content of this article which would seem to be of interest to the radiologist is included under the following heading:

Mechanism of Fracture and Anatomic Changes. As a result of light trauma a fissure of the anterior part of the septal cartilage with formation of hematoma may take place.

Dislocation of the anterior part of the septum occurs under the impetus of trauma which strikes laterally at the mobile part of the nose. When the direction of the striking force is anteroposterior and the septal cartilage is caught in the sagittal plane, lesions are at maximum. Then the septal cartilage affixed in the vomer groove posteriorly may bend or fracture laterally in its anterior segment.

Two varieties of fracture of the septum are observed: vertical and horizontal. The vertical fracture of the septum is the more common. The line of fracture extends downward and backward from the dorsum toward the nasal spine, dividing the cartilage into two segments: the posterior, which is the larger, and the anterior, displaced in the frontal plane. The dorsal border of the anterior fragment pulls the nasal tip to the same side. Clinically, a vertical fracture reveals itself by the oblique position of the anterior segment of the septal cartilage inside one nostril. The anterior border of the septum, through pressure, causes displacement of the inner crus of the lower part of the alar cartilage, which thus protrudes under the vestibular skin.

When the upper lateral cartilage does not resist the impact of trauma, simultaneously with the vertical fracture a rupture occurs between nasal bone and cartilage, with or without marginal fracture. The latter often manifests itself in an exuberant bony callus.

The horizontal fracture of the septum usually runs obliquely downward and forward and a few

millimeters above the free border of the vomer. Diagnostically, it is often confused with subluxation of the septal cartilage from the vomer groove, which often occurs simultaneously with lateral displacement of the dorsum.

If infection does not take place, the fragments are unified by fibrous tissue or by a thin layer of cartilage, as in a green-stick type of fracture. Histologic examinations have shown that a post-traumatic bend of septal cartilage occurring in early life often results later on in ossification and distortion of the cartilage.

Complete subluxation of the septum on the vomer produces a double deflection of the dorsum: a depression caused by traction downward and backward and a lateral displacement in the direction of trauma due to detachment of the upper lateral cartilage, often with marginal fractures.

Fracture of the nasal bones frequently accompanies dislocation of the cartilaginous components: The nasal bones, which are thick in the upper half, thin down conspicuously toward their lower border and are intimately united along their inner borders, forming a solid bony block in the midline. Their thickness varies from approximately 7 mm. in the upper half to about 0.5 mm. at the lower border. This explains why in lateral trauma a fracture of the nasal bones never occurs in the midline but occurs usually along the points of least resistance, namely, at their junction with the frontal processes. In severe injuries, fracture occurs on both sides, and there is lateral displacement of the entire bony dorsum.—*Mary Frances Vastine*

NECK AND CHEST

SCHILLING, J. A. Struma lymphomatosa, struma fibrosa and thyroiditis. *Surg., Gynec. & Obst.*, Nov., 1945, 81, 533-550.

Eleven cases are presented with clinical and pathological evidence to support their diagnosis. Six cases were diagnosed struma lymphomatosa; 2 cases were diagnosed struma fibrosa, and 3 cases represent the earlier, more acute, giant cell variant of struma fibrosa. Struma lymphomatosa is considered a distinct clinicopathologic entity. Its etiology is unknown, though it is considered a degenerative disease in contradistinction to a neoplastic or inflammatory disease. The excessive demands on the thyroid during the sexual life of the female are considered fundamental in the etiology of this disease. These excessive demands may be mediated through the hypophysis.

Struma fibrosa and its giant cell variant are considered two late manifestations of the thyroid from an acute to chronic inflammatory process. The fibrosis of the gland is considered first a replacement phenomenon of damaged glandular tissue. In later stages the diffuse infiltrating type of fibrosis may be due to a compensatory mechanism through constriction of the arteriolar blood supply of the gland, from a coincidental perithyroiditis.

Clinical Characteristics

1. *Age.* Acute thyroiditis occurs most frequently in young adults. The pseudogiant cell type of chronic thyroiditis and struma fibrosa occur in the third and fourth decades of life most frequently. Struma lymphomatosa occurs most often in the fourth or fifth decades.

2. *Sex.* Eighty-five per cent of the 3,750 patients admitted to the Strong Memorial Hospital, Rochester, N. Y., for thyroid disease were females. Thus the ratio of female to male with thyroid disease is roughly 6 to 1. The ratio of female to male in struma fibrosa is stated as roughly 3 to 2 or 4 to 1. In struma lymphomatosa almost 100 per cent of the patients are females.

3. *Predominant symptoms.* Symptoms are varied and often overlap, but, in general, the presenting symptom in struma lymphomatosa is *diffuse enlargement of the thyroid*. Occasionally mild pressure symptoms are noted such as dyspnea, dysphagia, hoarseness, voice change, tightness about the neck, cough or stridor. Signs and symptoms of early myxedema may be present.

With struma fibrosa, the symptoms are less vague than in struma lymphomatosa. *Pressure symptoms* are marked, often to such an extent that asphyxia seems imminent. Pain is usually absent.

With the giant cell variant of struma fibrosa, *pain* is usually the chief complaint and occurs in the neck or shoulder with radiation to the homolateral ear or back of the head.

4. *Response to roentgen treatment.* Struma lymphomatosa responds readily to roentgen therapy. This is in contrast to the lack of response of struma fibrosa. The response of pseudogiant cell chronic thyroiditis is unknown. Roentgen therapy may be used almost as a diagnostic test for struma lymphomatosa, provided that a preliminary biopsy has been taken to rule out malignancy.

5. *Postoperative course.* In general, with or

without operation, cases with struma lymphomatosa tend to become myxedematous and must be supported by thyroid extract. Struma fibrosa and its giant cell variant seldom cause myxedema provided that enough normal thyroid tissue has been allowed to remain after thyroidectomy. However, in struma fibrosa, pressure symptoms are apt to progress, and there is often a residual hardness toward the periphery of the lobes where resection was incomplete. The giant cell variant of struma fibrosa may subside spontaneously if left alone, though its symptoms may be so annoying that operation cannot be withheld.

6. *Laboratory.* Laboratory examination offers little diagnostic aid, with the exception of the basal metabolic rate which is usually normal or slightly elevated in struma fibrosa and its giant cell variant and low in struma lymphomatosa.

7. *Treatment.* Treatment of struma lymphomatosa by radiotherapy is the method of choice after a preliminary biopsy.

Surgery of struma fibrosa should be as conservative as possible. Its purpose is the relief of mechanical effects only as this disease is not neoplastic. Radiotherapy may be effective in the earlier, more acute, giant cell variant of struma fibrosa. The risk of operative complications of parathyroid tetany and recurrent laryngeal nerve paralysis is markedly increased in any radical attempt at extirpation of the gland and nullifies any potential relief of preoperative mechanical obstructive symptoms to the airway of the patient.

The end-result of treatment, barring surgical complications, is usually good, though with struma lymphomatosa there is a progressive tendency to myxedema.—*Mary Frances Vastine*

CARLTON, LEFFIE M., JR., and ADAMS, W. E. Resection of the lung in pulmonary suppurative diseases; factors contributing to its progress. *Surg., Gynec. & Obst.*, Dec., 1945, 81, 623-630.

The results of lung resection in 59 cases of pulmonary suppurative diseases are presented. The factors which contributed to a satisfactory result were: rapid and complete expansion of the remaining lung, replacement of blood loss, avoidance of anoxia and prevention of serious infection following operation. The dissection technique of resection is the procedure of choice in most cases. Chemotherapy has been a major factor in the prevention of serious postoperative infection. There were 2 deaths in 45 operations

made on 36 patients with bronchiectasis, 20 of which were bilateral.

In their discussion, the authors bring out the following points:

1. The surgical risk is considerably greater when there is bilateral involvement. Eight of the 20 bilateral group have had both operations completed, the course following the second operation being less difficult than after the first. This is partly due to the marked improvement that usually follows the first operation, thus making them better surgical risks, and also because little or no diseased lung remains after the second operation.

2. Clinical experience shows that human beings may tolerate the removal of a large percentage of the total lung capacity. Graham in 1940 reported the successful removal of both lower lobes, the right middle lobe and the lingula of the left upper lobe without the production of dyspnea or other physical handicap. In 2 of the authors' 8 completed bilateral operations, the same amount of lung resection was made. Both patients returned to full time work following surgery.

3. When bilateral operations are contemplated, sufficient time following the first operation for complete recovery and obtaining its beneficial effects should be allowed. This interval between operations may vary from six to twelve months or more depending on the occurrence of complications and the severity of the case.

4. The local and systemic use of sulfonamides in combination with the dissection technique is the procedure of choice in lobectomy for pulmonary suppuration. In 22 patients treated in this manner there were no bronchial fistulas and only 3 empyemas. Penicillin may replace the sulfa drugs as the chemotherapeutic agent of choice.

5. In pneumonectomy the pleural cavity is not drained following operation. Thus local sulfonamide therapy is less desirable because of the ill effects of rapid accumulation of fluid in the pleural cavity and collapse of the remaining lung. Penicillin, however, if deposited in the pleural cavity, may remain in effective concentration for twelve to twenty-four hours and without the production of an undue amount of pleural fluid.—*Mary Frances Vastine.*

McREYNOLDS, GEORGE S., JR., and SHELTON, FRED W. Bronchography as a diagnostic aid in chest disease. *Ann. Otol., Rhin. & Laryng.*, March, 1945, 54, 114-124.

The important factor in obtaining good bronchograms is the technique used. Iodo-chlorol was the opaque medium used by the authors since it is cheaper than, and apparently equally as efficient as, lipiodol.

Technique in Adults. Bronchography in adults is done under local anesthesia using 2 per cent pontocaine without epinephrine. The patients receive atropine and one of the barbiturates as premedication. The atropine is important since pontocaine has no inhibitory effect on the secretion of the mucosal glands and the barbiturates are used to offset any toxic effects of pontocaine.

A soft rubber catheter with a wire stylet is introduced into the glottis after which the stylet is withdrawn and the catheter passed down the trachea. The patient is then taken to the roentgen department where the catheter is manipulated into the proper bronchus under fluoroscopic visualization.

Technique in Children. After gas-ether induction, open drop ether is administered on the fluoroscopic table until the child is in deep third stage anesthesia. The anesthetic is then stopped. The larynx is exposed with a laryngoscope and the bronchoscope is introduced.

The authors usually fill both the right and left bronchial trees at one time to obviate the necessity of repeating the general anesthetic. However, one must be guided by the amount of pulmonary pathology present. When both lung fields are outlined, lateral films are of no value but oblique views are of great advantage.

With the patient in third stage anesthesia, the cough reflex is abolished and the breathing is slow and regular so that it is possible to get excellent films. One must have the complete cooperation of a competent anesthetist.

Contraindications. The authors have used the technique described in 20 children. No discernible ill effects have been noted. Several of the patients had such extensive suppuration that total pneumonectomy was required to effect a cure. It is felt that the aspiration of the bronchial tree before instillation of the iodized oil is an important factor in avoiding complications.—*Mary Frances Vastine.*

HOLINGER, PAUL H., HARA, H. JAMES, and HIRSCH, EDWIN F. Bronchogenic carcinoma. *Ann. Otol., Rhin., & Laryng.*, March, 1945, 54, 5-36.

It is generally conceded that there has been

not only an apparent but also an actual numerical increase in this disease. Bronchogenic carcinoma is fifth in frequency in types of carcinoma among males; it is surpassed only by carcinoma of the stomach, of the intestines and rectum, the prostate and bladder, and the liver and pancreas.

The present study is concerned with 175 proved cases of primary bronchogenic carcinoma observed principally at the Research and Educational Hospitals of the University of Illinois and at St. Luke's Hospital, Chicago, prior to February, 1944.

Etiology. It is generally agreed that no single agent is the sole cause but that a chronic irritant is an essential common factor.

Age, Sex and Race Distribution. Bronchogenic carcinoma is more frequently observed in white males. Seventy-two per cent of the authors' cases were between the ages of forty-five and sixty-four. The Negro male seems less susceptible to the disease than the white male.

Pathology. It is now believed that practically all carcinomas of the lung arise in bronchial tissue. Bronchogenic carcinoma shows a distinct predilection for the right bronchus.

The more common type occurs at or near the hilum.

Histopathologically, the commonest variety is the form composed of pavement epithelial cells and described as squamous cell.

Symptoms. The onset is always insidious. Almost all of the patients complained of disorders referable to the respiratory tract. Cough was the initial symptom in 50. Pain in the chest was the initial symptom in 14 patients.

Roentgenology. The principal feature roentgenologically is the extreme variation of the findings. An early tumor in a small peripheral bronchus frequently manifests itself only by an area of localized "pneumonitis" which appears entirely inflammatory in character. When such a lesion clears and then recurs, the probability that it is due to neoplasm is great.

Areas of pulmonary suppuration in older individuals, or otherwise unexplained pulmonary suppuration in a patient of any age, may well be due to pulmonary neoplasms.

A bronchus blocked by a tumor may become bronchiectatic in which case the bronchiectasis may be the outstanding roentgen finding.

The center of a solitary round tumor may become necrotic and evacuate itself to reveal a round shadow with the characteristic fluid level of a pulmonary abscess.

Thus it may be seen that the classical roentgen findings of bronchogenic carcinoma are those produced by varying degrees of bronchial obstruction. Small tumors on the wall of a bronchus produce no changes in most instances. Thus, negative roentgen findings in a patient who has occasional slight hemoptysis or who complains of a wheeze should not exclude further diagnostic studies, especially a bronchoscopic examination. Slightly larger tumors will manifest their presence on roentgenograms by signs of obstructive emphysema, the heart and mediastinum being shifted away from the affected side on expiration. Finally, total bronchial obstruction with collapse of the segment, the lobe, or the whole lung distal to the tumor is the most common roentgenologic manifestation of an intrabronchial neoplasm.

Bronchoscopy. The bronchoscopic picture is extremely variable. Usually the carcinoma is a soft, red, fungating papillomatous type of tumor which completely occludes a major bronchus.

Treatment. The treatment of bronchogenic carcinoma is primarily surgical. Roentgen therapy has received much consideration. In the authors' experience it has been of assistance in alleviating bronchial obstruction in some instances thus affording palliation.—*Mary Frances Vastine.*

GROSS, ROBERT E., and LEWIS, JAMES E., JR.
Defect of the anterior mediastinum; successful surgical repair. *Surg., Gynec. & Obst.*, May, 1945, 80, 549-554.

The substance of the anterior mediastinum is such that it offers relatively little resistance to displacement and hence it may bulge to either side. Herniation through the mediastinum is a well recognized phenomenon and has frequently been seen in conjunction with lesions which disturb the normal pressure relationships on the two sides of the chest. Under such circumstances a lung which bulges into the contralateral side of the thorax is always covered by its parietal pleura.

Distinct from subjects with a mediastinal hernia are those rare individuals in whom an actual communication exists between the two pleural spaces. This latter, congenital type of anatomical curiosity is probably best explained on the basis of an over-encroachment of the lungs in a forward and then medial direction during fetal life, so that the yielding anterior

mediastinum becomes compressed and resorbed. If such encroachment is of only moderate severity, a septum-like type of anterior mediastinum could presumably result—such as that normally present in the dog. If, however, the encroachment is more advanced, the pleurae which appose one another may disappear and an opening of variable size can develop between the two cavities.

A large communication between the pleural cavities, per se, probably causes no physiological abnormalities or clinical symptoms. However, a mediastinal opening is a definite hazard if in addition there is some associated malformation or disease which disturbs the pressure equality which normally exists in the two sides of the chest. An example of such a mechanism is demonstrated by the authors' case.

Summary of Case Report. A four year old child had a large opening in the anterior mediastinum, a free interpleural communication and an anomaly of the right upper lobe bronchus. Deficiency of the bronchial cartilage allowed this airway to collapse in such a manner that air entered the upper lobe and became entrapped therein. Marked emphysema of the right upper lobe allowed it to protrude through the mediastinal opening and to invade the left pleural cavity. This child had intermittent attacks of severe respiratory distress, dyspnea, and cyanosis. These were completely relieved by simultaneous closure of the anterior mediastinal defect and removal of the anomalous right upper lobe. This is apparently the first recorded instance of surgical repair of an anterior mediastinal defect.—*Mary Frances Vastine.*

WHITE, JAMES C., POPPEL, M. H., and ADAMS, RALPH. Congenital malformations of the first thoracic rib; cause of brachial neuralgia which simulates cervical rib syndrome. *Surg., Gynec. & Obst.*, Dec., 1945, 81, 643-659.

The circulatory disturbances and neuralgias of the upper extremity which frequently result from cervical ribs or hypertrophy of the anterior scalene muscle are well understood. It is not generally appreciated, however, that a similar picture may be produced by a congenital abnormality of the first thoracic rib. The authors review the literature and add 10 new examples of this little known anomaly. Five of these have come to operation for relief of specific complaints, while 5 others have re-

mained wholly asymptomatic. Roentgenograms are reproduced of 8 of the 10 cases to illustrate different varieties of the deformity.

Summary. Congenital anomalies of the first thoracic ribs are not extremely rare.

First rib malformations generally consist of a rudimentary structure terminating in a synostosis or pseudarthrosis with the second rib near the scalene tubercle, or in a free end in the soft tissues at the base of the neck, which may be connected by a ligamentous band with the manubrium sterni. On very rare occasions the first rib may have a distinct joint near its lateral angle before it fuses with the second.

Other skeletal abnormalities are frequently present which cause further distortion of the thoracic outlet. They consist of deformities of the second rib, the upper end of the sternum, scoliosis of the cervicothoracic spine, and vertebral anomalies.

Congenital malformations of first thoracic ribs are best explained by errors of bodily segmentation in early embryonic development. These are brought about by abnormal formation of the brachial plexus and blood vessels, which make their appearance before the bony skeleton. Examples of posterior fixation of the brachial plexus and abnormalities in the arrangement of the arteries at the thoracic outlet were encountered in 2 of the authors' cases.

Symptoms and clinical evidence of abnormal first ribs consist of supraclavicular bony prominence, irritation or paralysis of the brachial plexus, and compression of the subclavian vessels as they cross the defective rib.

Cervical arthritis, early carcinoma of the thoracic apex, and herniation of the lower cervical intervertebral discs must be considered in the differential diagnosis of brachial neuralgia even in the presence of an anomalous rib.

A considerable proportion of first rib deformities are large enough to cause direct mechanical compression of the nerves and vessels at the thoracic outlet. When symptoms are attributable to this condition, conservative orthopedic measures should be tried before surgical intervention. Scalenotomy alone rarely suffices to decompress these structures, but must usually be accompanied by radical resection of the rib from a point close to its articulation with the transverse process forward to its attachment to the second rib or where it disappears beneath the clavicle. In cases in which an incomplete removal has been per-

formed through the anterior supraclavicular approach, the central end of the rib may still cause irritation of the plexus. Resection of such a stump is then best accomplished through the posterior approach.—*Mary Frances Vastine.*

ABDOMEN

JONES, T. E., and KEHM, R. W. Total gastrectomy; report of eight cases. *Surg., Gynec. & Obst.*, May, 1945, 80, 534-538.

Indications. Total gastrectomy is particularly adaptable for the linitis plastica type of stomach. However, it is also indicated in neoplasm extending into the cardiac end of the stomach and, even in deep penetrating ulcers located high in the stomach and therefore not amenable to medical management or to subtotal gastrectomy.

Physiologic Effects of Total Gastrectomy. The digestive disturbances most commonly encountered are diarrhea, steatorrhea, dysphagia and biliary regurgitation.

Alterations in the hemopoietic system after total gastrectomy are to be expected. Castle showed that pernicious anemia is at least partly due to loss of intrinsic factor from the stomach. Yet paradoxical as it may seem, the anemia is usually not pernicious but rather secondary or iron deficiency anemia of the normocytic, normochromic type.

Observations. Total gastrectomy is of extreme scientific interest and will open new fields for experimental physiologists. Questions which remain to be answered are: Why do these patients not develop pernicious anemia if the intrinsic factor is necessary to hemopoiesis? Why is the removal of the stomach followed invariably by steatorrhea and occasionally by diarrhea? What digestive disturbances follow loss of gastric enzymes?—*Mary Frances Vastine.*

POLAYES, S. H., and NEVINS, THOMAS F. Fatal hemorrhage from an angiomatous polyp of ileum complicating pregnancy. *Am. J. Obst. & Gynec.*, Aug., 1945, 50, 207-212.

The literature contains reports of approximately 93 cases of angioma of the gastrointestinal tract. Kaijser collected and classified in table form 74 cases of angiomata of the gastrointestinal tract, of which 8 occurred in the ileum. In most instances, the angioma was one of several similar lesions co-existing in other segments of the intestines, especially in the jejunum. In very few was the lesion solitary and

limited to the ileum as in the case reported by the authors.

Discussion. Bleeding vascular lesions of the gastrointestinal tract may be due to telangiectasia (local or as an expression of a general diathesis), varicosities, or true neoplasms. The latter include cavernous angioma, capillary angioma, and angioendothelioma.

Grossly the lesions may manifest themselves in the form of ulcers, fungating bulky masses projecting into the lumen, or strictures.

In the case reported, a true neoplasm involving all layers of the portion of the ileum affected, was found. There was a marked tendency to nevus formation in the skin of this patient. There may have been a relationship to the angiomatous polyp in the ileum since many of the skin nevi were capillary angioma. Clinically it was noted that the pigmented nevi of skin became more accentuated and increased in number with pregnancy. It is conceivable that the state of gravidity activated the angioma as well as the skin nevi.

Kaijser mentions that in one of his cases of angioma of the stomach, bleeding increased with puberty. He mentioned puberty and gravidity among the endogenous stimuli which may activate the development of angiomata.—*Mary Frances Vastine.*

Griffin, William D., Bartron, George R., and Meyer, Karl A. Volvulus of the sigmoid colon; report of twenty-five cases. *Surg., Gynec. & Obst.*, Sept., 1945, 81, 287-294.

Volvulus of the sigmoid colon is very uncommon in the United States. This is not true in Eastern Europe, for of 215 cases of intestinal obstruction reported by Pearlman from a Russian clinic, 111, or more than half, were cases of volvulus.

The authors reviewed the clinical and surgical records and the roentgen studies on 25 cases of volvulus of the sigmoid. The following conclusions were reached:

1. There are two main types of sigmoid volvulus: a. Acute (7 cases), characterized by occurrence in the younger age groups, short onset, equivocal history of constipation, early transient emesis, generalized cramping abdominal pains, abdominal tenderness, acute distention, and marked prostration. These patients tend to develop gangrene early and run a fulminating course. b. Subacute (18 cases), characterized by occurrence in the older age

groups, of a more gradual onset of symptoms, history of previous attacks and constipation, and emesis late in the course of the disease. These patients tend to develop gangrene slowly and run a more moderate course.

2. Seventy-six per cent of the patients were unable to take an enema of more than 500 cc.

3. The single most helpful aid was roentgen examination. The typical roentgenographic findings are: tremendously dilated sigmoid loop situated in the right abdomen; moderate distention of the colon above the volvulus; absence of a collection of fluid within the bowel; "ace of spades" appearance of the barium enema opacity. (The barium enema shows a normal mucosal pattern in the sigmoid and rectum distal to the dilated loop. The upper end of the opacity, however, comes to a sharp point and produces the appearance of an "ace of spades".)

4. Volvulus of the sigmoid tends to recur and therefore simple detorsion is not the treatment of choice.

5. Exteriorization and second stage resection give the best results.—*Mary Frances Vastine.*

Hawe, Philip. The surgical aspect of intestinal amebiasis. *Surg., Gynec. & Obst.*, Oct., 1945, 81, 387-404.

The object of this paper is to review the types of intestinal amebiasis which frequently arise in surgical practice in endemic areas; distant complications, such as hepatic abscess, are not included. It is based on experience gained during four years of hospital work in the tropics and on a study of the literature. The observations are supplemented with illustrative examples from a series of 450 cases of intestinal amebiasis admitted to a British General Hospital in South India between July, 1942, and March, 1944.

Summary and Conclusions

1. Intestinal amebiasis is the disease of major surgical importance in endemic areas. With the return of the forces from the East, examples of this disease must be expected in general practice.

2. The clinical and roentgenological manifestations of the localized forms of intestinal amebiasis may be indistinguishable from those of surgical diseases, acute or chronic. It is usually, but not always, possible to find the *Endamoeba histolytica* in the stools; sigmoidoscopy may succeed when examination of the

stools fails. The response to emetine is of considerable diagnostic significance, but occasionally the condition is resistant to the drug, and exploration or biopsy is then required. The possible coexistence of amebiasis with other lesions must not be overlooked.

3. Perforation of an amebic ulcer is to be expected in less than 3 per cent of cases. It is most often associated with fulminating infections. Toxemia may mask the clinical signs, and if gangrene is present recovery, even with operation, is very unlikely.

4. The clinical features of acute cecal amebiasis and acute appendicitis have much in common; the differential diagnosis may present great difficulty, but in view of the special risks of operation in cases of cecal amebiasis, every endeavor should be made to obtain a clinical diagnosis. If exploration proves necessary, manipulation of the cecum should be avoided as far as possible, and, unless the appendix is obviously in a dangerous condition, it should not be removed if amebiasis is found; emetine should be given at once after operation.

5. However suggestive of acute appendicitis, operation should not be advised in any case with an inflammatory mass until cecal amebiasis has been excluded. Amebic appendicitis is regarded for purpose of diagnosis and treatment as an extension of cecal amebiasis—unless complicated by abscess or perforation, it is a medical disease.

6. Unsuspected intestinal amebiasis and post-dysenteric conditions of non-appendicular origin often give rise to symptoms very suggestive of chronic appendicitis. Before appendectomy is advised, these conditions must be carefully excluded. Operation is occasionally required for residual appendicular disease following cecal amebiasis.

7. Examples of localized chronic amebic colitis and ulceration of the rectum which may be mistaken for carcinoma or other surgical diseases are common in endemic areas. Minor anorectal conditions, such as piles, fissure and fistula, may result from unsuspected mild or chronic amebiasis.

8. With few exceptions, abdominal or rectal operations are strongly contraindicated in patients suffering from intestinal amebiasis—they are often followed by serious complications peculiar to this disease. If operation is necessary, or if amebiasis is discovered at exploratory operation, the sooner the emetine is commenced the better. Appendicostomy and ceco-

stomy have no place in the treatment of this condition.—*Mary Frances Vastine.*

GYNECOLOGY AND OBSTETRICS

WILLSON, J. ROBERT. Carcinoma of the cervix complicated by pregnancy. *Am. J. Obst. & Gynec.*, Sept., 1945, 50, 275-283.

Six patients with carcinoma of the cervix and pregnancy have been treated at the Chicago Lying-in Hospital since 1931.

Diagnosis. Bleeding which appears during early pregnancy and which persists for more than one week despite bed rest may be due to a malignancy. There are no subjective symptoms in the early case of carcinoma of the cervix. The signs during pregnancy are exactly like those which characterize the same lesion in the non-pregnant uterus: abnormal discharge or bleeding which, characteristically, is painless, irregular, progressive in amount, and prone to follow trauma.

Prognosis. The prognosis for carcinoma of the cervix discovered during pregnancy and properly treated seems to be at least as good as that in the non-pregnant individual. The belief that the rate of growth of carcinoma of the cervix is increased by the pregnancy has not been substantiated. Peller, after demonstrating that the relative number of carcinomas occurring during pregnancy was significantly less than the number occurring in similar age groups in the non-pregnant, concluded that pregnancy not only increases the resistance to cancer, but raises the average age of its occurrence and retards its progress.

It has been suggested that the marked rise in the estrogenic hormones during pregnancy may be a factor both in the production and extension of the disease. However, no malignancies developed in a group of animals studied by Emge and he concluded that the rôle of the estrogenic hormones in the production of cancer is secondary to, and limited by, the hereditary factors.

The Fetus. If external irradiation is given over the uterus during early pregnancy and abortion does not follow, fetal abnormalities occur in a high percentage of cases. Microcephalic idiocy has been the defect most commonly noted. Murphy advises artificial interruption of any pregnancy which continues after irradiation.

Treatment.

1. First trimester—Roentgen therapy should

be started as soon as the diagnosis is established. If abortion does not occur (usually during the third week), curettage is done. External irradiation (3,000 r to each parametrium) is followed by radium insertion after the uterus is empty. The total radium dosage consists of at least 5,000 mg-hr. of which one-third is delivered to the uterus and two-thirds to the cervix and surrounding parametrium.

2. Second trimester—Early in this trimester, treatment is as above but the interruption of pregnancy is less consistent. Effective irradiation to the pelvis is therefore diminished because of the increased size of the uterus.

During the late second trimester, an initial surface interstitial and/or intracervical application of the radium may be followed, after the reaction has subsided, by cesarean hysterectomy. A complete course of roentgen therapy, which may be started as soon as the wound is healed, is followed by the intrauterine application of radium to complete the total dosage. Delivery from below is contraindicated unless the lesion is very small.

3. Third trimester—The treatment in this period is much like that during the latter part of the second trimester. There is no reason for delaying the initial treatment of the cancer. In the majority of cases, abdominal delivery is the method of choice.

Summary. A high fetal mortality is inevitable since it is usually unwise to resort to methods of treatment which attempt to preserve the fetus but which may decrease the chances for cure of the neoplasm.—*Mary Frances Vastine.*

MELODY, GEORGE F., FAULKNER, ROBERT L., and STONE, SIDNEY J. Adenoacanthoma of the ovary. *Am. J. Obst. & Gynec.*, May, 1945, 49, 691-695.

The term adenoacanthoma is applied to tumors composed of glandular and squamous elements. Descriptions of such lesions encountered in the esophagus, stomach, gallbladder, pancreas, sigmoid, thyroid and lung have been reported sporadically in the literature. The fact that occasionally, carcinoma of the corpus uteri are composed of both glandular and squamous cells is well known. The authors have been unable to find any case reports of primary adenoacanthoma of the ovary. Two such cases are presented by them.

Discussion. It is the conclusion of Novak that the "epidermization" as seen in fundal adenoacanthoma is the result of metaplasia of

the cylindrical to the squamous type of epithelium. A study of cervical biopsy material reveals the very great frequency of metaplasia of the normal columnar to the squamous type of epithelium in inflammatory lesions of the cervix uteri. Moreover, it is recognized that the germinal epithelium covering ovaries which are involved in chronic perioophoritis occasionally undergoes squamous metaplasia. Then, there is the condition known as cystic fibrosis of the pancreas in which, due to the impaired absorption of fat-soluble vitamin A, there is a pronounced squamous metaplasia of the bronchial mucosa. It would appear, therefore, that squamous metaplasia is really of rather frequent occurrence in a wide variety of pathologic processes, running the gamut from chronic inflammatory lesions, and a vitamin deficiency state, to frank neoplasms. It seems entirely tenable, therefore, to assume that the squamous elements in the ovarian adenoacanthomas herein presented are, in fact, the result of the ubiquitous process of metaplasia.

Another plausible hypothesis for the presence of squamous epithelium in ovarian carcinoma is the supposition that such may result from Walthard's islands. According to Ewing, the latter are thought to result from "invaginations of celomic epithelium." The manifold possibilities of celomic epithelium on differentiation are well known. It may well be that the origin of the squamous elements in ovarian acanthoma is identical with the generally accepted theory of histogenesis of Brenner tumor, viz., Walthard's rests.—*Mary Frances Vastine.*

HODGSON, JANE E., DOCKERTY, M. B., and MUSSEY, R. D. Granulosa cell tumor of the ovary; clinical and pathologic review of sixty-two cases. *Surg., Gynec. & Obst.*, Dec., 1945, 81, 631-642.

In their summary and conclusions, the authors include the following observations as a result of their study of 62 granulosa cell tumors.

1. These 62 granulosa cell tumors removed surgically between 1910 and 1944 constitute 1.63 per cent of the ovarian tumors (3,800) encountered during this period. About 60 per cent of these tumors were found in women who had passed the menopause.

2. The most common clinical symptoms were uterine bleeding (74 per cent), amenorrhea (22 per cent), and abdominal enlargement (29 per cent). The tumors that produced these symptoms grew slowly and might have been present

for as long as thirty-five years.

3. Urinary assays in one case (a woman aged fifty-seven) were positive for 8 rat units of estrogen per liter of urine excreted during the first twenty-four postoperative hours. The excretion dropped to zero during the next twenty-four hours.

4. Further evidence of hyperestrinism in this series is afforded by symptoms of precocious puberty, amenorrhea, and postmenopausal bleeding and is supported by the incidence of adenomyosis and endometriosis (0.6 per cent) which often occurred in post-menopausal patients; uterine fibromyomas (51.6 per cent); uterine hypertrophy (59.6 per cent) and proliferative endometrium (67 per cent).

5. There is a suggestion that granulosa cell tumors may produce the differentiative hormone, progesterone.

6. Twenty-one per cent of the 38 postmenopausal patients who had granulosa cell tumor also had endometrial carcinoma. In 3 of these cases, carcinoma of the breast also developed. This phenomenon of coexistent ovarian, endometrial, and mammary carcinoma in the human being bears a marked similarity to the results of experiments on laboratory animals in which estrogen stimulation appears to be a factor in carcinogenesis.

7. Pathologically, the tumors appeared to be of a low order of malignancy as determined by histologic grading.

8. Chemical analysis of four granulosa cell tumors indicated an excess of cholesterol and cholesterol esters as compared to the normal content of these substances in the ovaries. In general, this increase in lipid content was thought to be related to storage of estrogenic hormone.

9. In this group of 62 cases of granulosa cell tumor there were 4 definite recurrences and 1 possible recurrence. The appreciable incidence of recurrences among older patients indicated that bilateral oophorectomy with hysterectomy is advisable for granulosa cell tumors affecting women past middle life. Less radical procedures, on the other hand, seem to be indicated for granulosa cell tumor among younger women inasmuch as no recurrences were noted and pregnancy subsequently occurred in 3 cases.

10. The authors' experience with postoperative irradiation for granulosa cell tumors in postmenopausal patients is not sufficient to warrant recommendations concerning this mode of treatment. However, it cannot be stated that

such treatment might not be of value. Preoperative irradiation of the tumor may produce temporary regression with cessation of postmenopausal bleeding. If granulosa cell tumors are to be cured by irradiation, apparently the dosage must be markedly increased, if feasible, above the amount hitherto employed.—*Mary Frances Vastine.*

GENITOURINARY SYSTEM

MOE, RUSSELL J. Duplication of right kidney pelvis and ureter with extravesical ureteral opening. *Am. J. Obst. & Gynec.*, May, 1945, 49, 641-646.

Ectopic ureters are found more frequently in females than in males, the ratio being about 2:1. The reason for this is that in the female an ectopic ureter usually opens distal to the vesical sphincter and produces a dribbling incontinence in females is found present since birth, but in spite of this there is normal emptying of the bladder.

Diagnosis. A dribbling incontinence of urine in the presence of normal bladder function is pathognomonic of ectopic ureter when occurring in a female. In the majority of instances this symptom has been present as long as the patient can remember. In a few reported instances the incontinence is present only when the patient is in the upright position.

Much patience and diligence are often necessary in locating the orifice of the ectopic ureter. An intravenous pyelogram which shows multiple pelvis on one side, and this in the presence of incontinence, should make one suspicious of an ectopic ureter.

According to Weigert's law, the ureter draining the upper part of the kidney opens lower in the urinary tract and it is always this orifice which is ectopic.

Treatment. The functional value of the kidney on the opposite side should be determined before any treatment is attempted.

Heminephrectomy seems to be the procedure of choice where the segment of kidney drained by the ectopic ureter is small and therefore functionally of little value.

The accessory kidney pelvis and ureter are usually infected so implantation of the accessory ureter into the bladder does not seem to be a wise procedure.—*Mary Frances Vastine.*

PRATT, J. P., and SCHAEFFER, ROBERT L. Sex precocity, virilism, adrenal cortical tumor.

Am. J. Obs. & Gynec., May, 1945, 49, 623-633.

Classification of sex precocity is difficult because no two cases reported are exactly alike. The alteration in development may be due to (1) endocrine hyperfunctional tumors (adrenal, ovary, testis), (2) endocrine hyperfunction with or without cellular hyperplasia, (3) tumors in the region of the third ventricle, and (4) pineal tumor.

Sex precocity is not rare. In survey of 2,311 delinquents in the preadolescent and adolescent age groups, it was revealed that sex precocity occurred in thirteen, or 6.8 per cent of them. Three case reports are given:

Case 1. A girl, aged two years nine months, who showed marked signs of virilism, was operated upon and an encapsulated tumor in the right adrenal was removed. At the end of a period of six years there have been no signs of metastasis. There has been marked reversal from the original picture to that of the normal female child.

Case 2. A female child at four months of age presented signs of virilism which increased until near her death at the age of twenty-five months. The first lesion noted was fibrosarcoma of the cheek. This metastasized to the left adrenal which accounted for the signs of virilism. The death of the patient was due to the malignant tumor of the cheek and its metastases. The virilism appeared as a consequence of metastases to the adrenal.

Case 3. This girl, aged eight years four months, displayed signs suggesting virilism. Adrenal tumor was suspected, but exploratory operation revealed no adrenal enlargement. The discrepancies, when compared with the other two patients, were lack of increased statural growth, no change in voice, and only moderate enlargement of the clitoris. Her behavior was masculine.

Discussion. Sex precocity is more frequent in the female. Virilism in the female signifies sex reversal and is comparable with sex precocity in the male.

In his discussion of this paper, Dr. Novak brings out the following points: (1) The distinction which gynecologists most frequently must make in the cases of precocious puberty is between that of the granulosa cell tumor variety and that of constitutional type. The other possible causes are, as a rule, readily eliminated. For example in the adrenal cases, a precocious

puberty characterized by heterologous sex characters is exhibited. They show hypertrichosis but the hair growth involves not only the genitals and axillae, but usually other parts of the body, like the abdomen or extremities, with at times tufts of hair on the back. In the granulosa and constitutional cases, on the other hand, the hair is apt to be limited to the genitals and axillae, just as it is in the girl at normal puberty.

(2) In the adrenal cases there is often marked hypertrophy of the clitoris which is never seen in the constitutional or granulosa-cell tumor cases. Finally, the precocious development seen in the adrenal cases is associated in only a minority of cases with precocious menstruation, a characteristic manifestation in the other two chief varieties.

(3) The pineal tumor group, the tumor usually being a teratoma, does not concern the gynecologist, since practically all known instances have occurred in males. Furthermore, the precocious changes are probably due to involvement of certain brain areas rather than of the pineal body itself. Other causes of precocious puberty, such as tumors of the hypothalamic areas, are commonly characterized by definite cerebral symptoms far graver than the precocious sex changes.

(4) The granulosa cell tumor variety presents changes like those we might expect from the administration of large amounts of estrogen to infants or young children, and the menstrual bleeding which they show is purely estrogen-induced and not associated with ovulation. In this important respect they differ from the far more common cases of constitutional or genic type, in which ovulation does occur, precocious pregnancy being, therefore, possible. Unless one can actually palpate an enlargement in one or the other ovary, one should lean toward the diagnosis of the constitutional type.—*Mary Frances Vastine.*

SKELETAL SYSTEM

KNEPPER, PAUL A. Parachute fractures. *Surg., Gynec. & Obst.*, July, 1945, 81, 53-55.

A survey of fractures which occurred in a regiment of paratroop infantry during a six month period of intensive training is presented. The over-all incidence of casualties was as high as 10 per cent in some of the jumps at the beginning of training. The number of accidents was rapidly reduced until at the end of the pe-

riod of training, the casualty rate was less than 1 per cent.

The optimum speed of the airplane during release of parachutes is about 100 miles per hour for a static line jump. The jumps were made at 800 feet above ground level in the beginning of training, gradually dropping to 600 feet as the program went on. The impact at which the parachutist hits the ground is equal to that of a fall from a height of 10 to 15 feet. A wind of over twelve to fifteen miles per hour greatly increases the number of casualties.

Types of Injuries in Parachute Jumpers.

1. Psychoneuroses, including hysterical states and malingering, were very uncommon.

2. Back injuries were not common. There were 7 cases of compression fractures of the vertebrae. None was complicated by paralysis. No cases of protruded intervertebral disc were found. Back sprains of any severity were uncommon as the men were taught to land on their feet and roll forward. The 7 cases of compression fracture were all associated with one or two complications; the primary "chute" did not open and the secondary "chute" was used, or another parachutist accidentally emptied part of the air from the "chute" which carried the man who was injured. There were no compound fractures and no fatal accidents.

3. Head injuries included 2 linear fractures and 4 basilar ones. These injuries all happened in a high wind which caused the parachutist to land sideways, striking the head in some manner.

4. Acromioclavicular separations were not common. Injuries to the acromioclavicular joint were treated by depression of the clavicle and immobilization. Separation of the conoid and trapezoid ligaments was repaired by open operation.

5. Fracture of the posterior lip of the tibia is so typical a parachute injury that it has been named "paratrooper fracture" by Tobin. Parachutists were taught to land on the ball of the foot. This is possible if there is no wind and the terrain is even, but too often this is not the situation. These fractures occur when the weight of the body is transmitted through one foot instead of being divided.

A method of treatment was established: (1) A padded plaster cast is applied from the base of the toes to the tibial tuberosity. (2) The foot is placed in the neutral position. (3) The ankle is placed in exactly 90 degrees dorsiflexion. (4)

An anesthetic may be necessary to get the ankle in proper position. (5) The patient is on absolute bed rest for one week, with elevation of the extremity on two pillows. (6) After one week, the cast is removed and replaced by another cast with a very small amount of padding. A section of wool felt 2 by 2 inches is placed dorsally over the tarsal bones. (7) After forty-eight hours the patient is allowed to walk on the leg. No crutches or walking calipers are employed. The cast will frequently break on the bottom but good support is given to the ankle nevertheless. (8) The cast is removed after two weeks and daily whirlpool baths of thirty minutes in the morning and infra-red treatment for one hour in the afternoon are given. One week of this treatment will suffice ordinarily and parachutist is ready for full duty, including marches.—*Mary Frances Vastine.*

SCHMIER, ADOLPH A. The internal epicondylar epiphysis and elbow injuries. *Surg., Gynec. & Obst.*, April, 1945, 80, 416-421.

Fracture dislocation of the elbow in children with inclusion of the internal humeral epicondyle into the joint is not a frequent injury. It is not as rare, however, as was formerly believed. The injury is of extreme importance since the full significance of the pathology is not always appreciated. The dislocation is easily diagnosed, but the displacement of the internal epicondyle into the joint is often unrecognized; the dislocation is reduced but the epicondyle remains within the joint. As a result the child may be doomed to markedly restricted painful range of motion in the elbow. It is highly important to suspect and look for a displacement of the internal humeral epicondyle in every case of elbow dislocation in children.

Clinical Examination. This gives some indication of the injury present. A dislocation is obvious and is easily recognized. The normal prominence of the internal humeral epicondyle should be looked for and its absence noted. Comparison should be made with the opposite normal elbow. The presence of localized tenderness over the region of the epicondyle may be significant.

The internal humeral epicondyle gives origin to a group of muscles by a conjoined tendon. These muscles are the pronator teres, flexor carpi radialis, palmaris longus, flexor digitorum sublimis (humeral head). By their action these muscles pronate the forearm, flex the wrist and fingers, and aid in flexing the elbow.

The center of ossification of the internal humeral epicondyle appears at about the age of five years and fuses at about the age of eighteen years.

Evaluation of Study. Avulsion of the internal humeral epicondyle may be simple or may accompany elbow dislocation. Conversely, dislocation of the elbow may occur alone or be accompanied by a separation of the internal humeral epicondyle. In those cases of dislocation in which the epicondyle becomes displaced within the joint it is highly important that the entire pathology be recognized early and treated without delay. Complete reduction can be obtained in those cases that are treated early by the closed method described by the author. The maximum length of time following injury in which closed reduction may be successful cannot be stated with accuracy. All of the patients in this series in which the dislocations were successfully reduced by the closed method were treated within twenty-four hours after injury. All of them obtained well functioning painless elbows.—*Mary Frances Vastine.*

MISCELLANEOUS

MERRITT, E. A., DEN, A. J., and WILCOX, U. V. The effects of radiation therapy in clostridium infection in sheep. *Radiology*, Oct., 1944, 43, 325-329.

Experiments in the treatment of clostridium infection in sheep by irradiation were carried on for four months in 1942. Sheep were selected as experimental animals because the surface irradiated is a prime factor in computing radiation doses and this surface is about the same in sheep as in man. Twelve sheep with an average weight of 80 lb. were used and later 4 sheep with an average weight of 120 lb. added. The latter strain was more resistant to the disease than the former and so modified the statistical results.

The mortality in the untreated animals of the first group was 86 per cent, while after the addition of the second group it was 75 per cent; the mortality of the treated animals in the first group was 25 per cent before including the additional animals and 29 per cent after including them. The gangrenous process was more extensive in the untreated than in the treated animals. In all the treated animals the infection was limited to the inoculated thigh and leg and never spread across the perineum or along the flank on the affected side. The

immunity of animals should be tested before they are used for such experiments and those that are found immune rejected.

The regulation U. S. Army mobile field unit was used for examination and treatment. Doses from 600 to 1,600 r were given, but treatment was determined in each case by the severity of the disease and the general condition of the animal. The best results were seen in animals that were given an early initial treatment of 300 r with a second treatment of at least 200 r within six hours. There is no absolute rule for treatment except to treat early and adequately.—*Audrey G. Morgan.*

QUIMBY, EDITH H. Dosage table for linear radium sources. *Radiology*, Dec., 1944, 43, 572-577.

Information in regard to dosage in gamma roentgens from linear sources such as are used in the treatment of cervical and rectal cancer has not heretofore been available. The author describes her method of determining dosage along a linear source and gives a diagram illustrating it and a table showing the gamma roentgens per 100 mg.-hr. delivered at various distances from various points along such linear sources. No allowance is made for tissue absorption or scatter. Examples illustrating the use of the table are given. It is a simple matter to determine the dose delivered at any point within a reasonable range of any linear source or simple combination of such sources kept in place for any specified time by the methods illustrated in these examples.—*Audrey G. Morgan.*

GRAY, L. H., ELLIS, F., FAIRCHILD, G. C., and PATERSON, E. Dosage-rate in radiotherapy; symposium. *Brit. J. Radiol.*, Nov., 1944, 17, 327-342.

This is a very technical study of the effect of dosage rate in radiotherapy, illustrated with curves and tables showing the conclusions arrived at and the reasons for such conclusions. It is based on experimental work on isolated tissues and cells, and the problems faced by the radiotherapist in treating the human body are more complex but the conclusions reached here may prove a valuable guide to the therapist.

It seems probable that greater effects can be obtained by the use of high dosage rates than by the use of low ones and that a high intensity irradiation causes more damage to malignant

tissue than a low intensity irradiation without a corresponding increase in the damage to normal tissue. This conclusion seems to be confirmed by histological study and clinical observation. It is probable that the damage to malignant tissue is as permanent with high intensity irradiation as with low intensity irradiation. It is also probable that increased effects are obtained by prolonging the total time of irradiation and that the cause of this better effect is a greater uniformity of response in the cells of irradiated cultures.—*Audrey G. Morgan.*

MAYNEORD, W. V. Energy absorption. III. The mathematical theory of integral dose and its applications in practice. *Brit. J. Radiol.*, Dec., 1944, 17, 359-367.

This is a very technical discussion of the mathematical theory of integral dose in whole

body irradiation. "Volume integral dose," "surface integral dose" and "line integral dose" are defined and the mathematical working out of the conclusions given in detail. Tables are given showing data in regard to integral dose during whole body irradiation of patients of varying size and shape. In a later paper it is hoped to discuss problems in the study of radium therapy with the sources of radiation near to or inside the body. Two mechanical methods of finding integral dose are described, one by measurement of the movement of planes about a fulcrum and the other by weighing "tongues" of isodose curves cut from the roentgen film and dividing the weight of the bundle of tongues by the weight per unit area of the film. This is perhaps the easiest method of finding surface integral dose in a given plane.—*Audrey G. Morgan.*



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